Geography Teaching

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FOREWORD BY : ROBERT W. STEEL

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GEOGRAPHY TEACHING

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by

O.P. VARMA

M.A., B.T., F.R.G.S. (*London*)

Foreword by

ROBERT W. STEEL

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INSTITUTE OF EDUCATION FOR WOMEN
3596
Deptt of Extension
Services.
23/2/79
CALCUTTA-27

STERLING PUBLISHERS PVT LTD
AB/9 Safdarjang Enclave, New Delhi-110016

First Edition, 1971
Second revised and enlarged edition, 1975
Reprint, September 1977

Geography Teaching
©1977, O.P. Varma
Published by S.K. Ghai, Managing Director, Sterling Publishers Pvt. Ltd., AB 9, Safdarjang Enclave, New Delhi-110016 & Printed at Jayyed Press, Delhi-
Price Rs 16

FOREWORD

I am very happy to be asked to write a foreword for the revised and enlarged edition of Mr. O.P. Varma's *Geography Teaching*. His book, which was originally published a quarter of a century ago, is designed to meet the needs of all teachers of the subject and particularly those of students who are preparing to become geography teacher. Mr. Varma taught geography for some years in training colleges and is, therefore, very well aware of the problems that face the teacher in the class-room. The earlier editions of his book have helped many geographers in India to present their material to their pupils more effectively and to stimulate interest in a subject that can as all true geographers know, be very exciting indeed. It is my hope that this new version will be as warmly welcomed by those for whom it has been prepared as the previous editions have been appreciated by those who have benefited from studying them.

At the beginning of the 'seventies' much that is new is happening in geography as in the field of education generally. Some of these developments are already affecting teaching in India; others have only been slightly experienced as yet. Mr. Varma has recognized that there have been many changes since his book was first published in 1945 and has noted them in the course of the revision and expansion of his material.

The future of any subject in our universities or training colleges, or as an established discipline in the field of education, depends in large measure upon its image in the schools among those who at a young age are exposed to its practitioners. Recruits to ensure its continued progress in higher education will come only as pupils are stimulated in schools. It is vital, therfore, for the future of geography in India that it should be better taught at all levels in schools as well as elsewhere, and Mr. Varma's book will be a contribution towards this very desirable objective. It will be an aid to the progress of a subject that was greatly helped by the holding of the 21st International Geographical Congress and its associated symposia and field excursions in India during November-December, 1968.

The author has selected, arranged and presented his facts in a lucid and logical manner and has illustrated his text with many appropriate drawings and diagrams. He has considered the problems that arise from faulty teaching and suggests the important role that visual aids can play in capturing the interest and imagination of pupils. He is equally concerned with gifted and backward students. He recognizes too that teaching is no longer the business of the teacher alone ; the active and responsible part played by the pupils is equally important, the essential role of the teacher being to place those whom he is teaching in situations where they can learn.

Mr. Varma has, I understood, received many comments and suggestions from those who have used *Geograyhy Teaching* in the past. He has noted these just as he has taken account of many of the new findings about both geography and education in India and elsewhere. Not every teacher will adopt his approach or use his methods, but a book of this nature is not meant to be followed slavishly. The essence of good teaching is for everyone to follow his own individual line, and this book will serve its purpose if it excites interest, encourages enquiry and even provokes disagreement.

Liverpool, England. *Robert W. Steel*

PREFACE

The first edition of this book was written out of sheer necessity so as to provide young trainees with a useful and handy volume and each of the subsequent editions was more or less a replica of the first edition. Since the publication of the first edition, the science of geography has made rapid strides. Significant progress has been registered in the training of gerographers in the higher levels and of teachers engaged in secondary schools and training colleges. The development of geography has also witnessed the greatest innovations in the field of methodology and in its accompanied methods of teaching. This new phase in the science of geography is evident from the deliberations of the 21st International Geographical Congress held in December 1968 at New Delhi. My participation in the Congress greatly enriched my knowledge and inspired me to incorporate in my book the latest development in geography teaching. Thus, it is the favourable response received by the previous editions coupled with the major revolution in the subject of geography and methodology of teaching that urged me to write this volume.

The reform movement in the field of education has established three basic principles. Firstly, learning is an integral part of the learner, secondly, teaching is not merely injecting ideas into the brains of the pupils and thirdly, it is the duty of the teacher to place pupils into such favourable situations in which they can learn the most and the best. These constitute the fundamentals of the modern philosophy of education. Consequently, stress has been laid in the text on the specific teaching techniques in geography teaching. Much of the advice given to prospective teachers is bound to be formal until they have developed a measure of self-confidence. The text thus highlights the scope of formal teaching techniques and also points out their limitations. It emphasises the need for co-ordinating teaching aids and procedures in the class room and contains a detailed description of the methods by which the teacher can inculcate a sense of responsibility amongst his students to learn by their own efforts. Lastly, it portrays a complete identity between the educational and subject matter goals as each is an inseparable part of the other.

A few words may be mentioned about the organisation of the book. The framework of the text has been set into four parts. In the first part, the aim is to acquaint prospective teachers with the basic techniques. With this end in view, the whole portion of the earlier editions has been completely rewritten and in addition, three new chapters viz. Modern Concepts of Geography, Aid to Teaching, and Audio Visual Aids, have been added. Part II has also been completely rewritten and expanded so as to cover the branch of geography called "Physiograpny" in ten chapters as against three in the earlier editions. Part III of the book has been reorganised to consolidate the portions on Practical Geography like Scale, Elementary Surveying, Maps and Geographical Illustrations, Survey of India Maps and Map reading and the study of Weather Maps. The object is to give proficiency to pupil teachers in the practical aspects of geography. Part IV has also been expanded by including a new sample notes-of-lesson on "Rice Cultivation in Monsoon Asia", thus increasing the number of notes-of-lesson to five. In addition, a new chapter on "Lesson Plan" has been written so as to illustrate how the matter and method can go hand in hand. Experience has shown that the pupil teachers feel nervous and shaky while preparing a plan of a geography lesson and presanting it to the pupils. Holding the attention of the pupils is a great headache for a prospective teacher. It is sincerely hoped that after going through Part IV of the book, the prospective teacher under training will gain confidence to hold the attention of the pupils and in addition immensely improve his own capabilities for his professional growth.

In short, this edition has been given a new format and the whole text has been thoroughly revised and brought completely up-to date. Special care has been taken to reorganise the material, a considerable part of which, has been rewritten. Opportunities have been availed of for reviewing the existing material and adding a good number of new chapters. It is an admitted fact that teaching is an individual affair and is not subject to any hard and fast rules. The treatment and presentation of the material have been given utmost care as to prove useful to the inexperienced teachers. The organisation of the chapters is such that each is independent of the others and can be studied without much cross reference.

There is no denying the fact that it is not possible to deal effectively with all the essential aspects of teaching. It will not be enough to tell the students that aids are useful to teaching devices and geography teachers have the responsibility of developing tastes and interest of the pupils in the subject, but the prospective teachers will have to be impressed upon as to what constitutes good and effective aids and how best to use them. I have attempted to bring home to my readers the practical aspects of teaching the subject by giving specific illustrations of its procedures. Any book, in order that it really proves beneficial, should do more than give practical aids. A prospective teacher should be able to appreciate the role of aids in propagating knowledge and gain enough experience to select wisely the appropriate aids. In this manner, the prospective teachers are likely to develop a philosophy of teaching which will make them independent in their approach to the subject. The text tries to help the teachers-in-training recognise the ways in which they can create favourable conditions for their pupils to respond to the teacher's gestures during the course of the lesson.

I would like to see young teachers going for geography teaching with a broad vision of their professional responsibilities. Geography teaching can be one of the most rewarding jobs if the teacher can find satisfaction in his work. I earnestly hope that this revised and enlarged edition will be well-received by prospective teachers-in-training, as well as by the experienced teachers of schools and training colleges.

The book has profited well from the careful scrutiny and useful suggestions of my helpful friends. I am indebted to Dr. S.P. Chatterjee of the National Atlas Organisation and President, International Geographical Union for having allowed me to use freely all the publications brought out in connection with the 21st International Geographical Congress. I am also grateful to Dr. R.W. Steel, the John Rankin Professor of Geography and head of the Department of Geography, University of Liverpool (U.K.), and President of the Royal Geographical Society, London, for giving me valuable suggestions in improving the text.

I am grateful to my friend, Mr. R.K. Chowdhury for going through the manuscript and helping me in preparing the Index. I should express my thanks to my daughters Chanda and Rupa for preparing the diagrams, particularly those of the physiography portion and helping me in many other ways.

O.P. Varma

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Lesson Plan and Notes of Lessons

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PART I

THE TEACHING OF GEOGRAPHY

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1

Making of Geography

I. Descriptive Geography

Geography is as old as mankind. Man had to think of environment, food and shelter from the very beginning of his existence on earth. Before Christ, there existed certain settled states along the river basins of the Nile, the Tigris and the Euphrates. Among those who came into prominence were the Babylonians in 2400 B.C., the Aryans in 2000 B.C., the Phoenicians and lastly the Greeks who went to the west as far as Gibraltar. Travellers and conquerors were inspired to know about this inhabited earth, its inhabitants, its shape and the size and its relation with the universe. Among those who took initiative, the Greeks played the most important role by establishing trade and commercial relations with other states as early as the 7th century B.C. These travellers and conquerors on their return from their journeys related accounts of their travels and experiences in the form of stories and poems. Thus the poems of Homer and the stories of Odysseus are well-known. At that time it was thought by the Egyptians that the earth was oblong in shape and that their own country was its centre.

Among the notable travellers who contributed substantially to the study of geography were the following :—

1. *Pythagoras*, born in Samos in 582 B.C., was a great Egyptian traveller and was the first to find out the shape of the earth and its position in the universe. He said that the globular earth is revolving with other five planets round some fire and that the earth is also rotating round its axis.

2. *Herodotus* of Halicarnassus (484-425 B.C.) is known as the father of geography. We inherit from him the well-known epithet, 'Egypt is the gift of the Nile'.

3. *Plato* contributed a lot towards human geography by explaining the bearing of physical factors on the character of the Greeks.

4. *Aristotle* explained the eclipses.

5. *Alexander*, the Great, added much to geography through his conquests and it was he who founded the town of Alexandria. He also prepared maps of his routes and the places he conquered.

6. Next came the Roman Empire which developed much of mathematical geography. The circumference of the earth was calculated as 25,000 miles and a map was also prepared. *Hipoarchus*, the Roman astronomer, introduced the idea of latitudes and longitudes, *Strabo*, the great historian, wrote an encyclopaedia of geographical information in 17 volumes. *Ptolemy*, the cartographer, evolved the science of preparing maps.

7. The Christian era did not contribute much to geography except for some minor additions here and there. After this, Muslim culture became important particularly in relation to geography. The Arabs were the first to show their interest in geography because of their special surroundings. Quite a good number of Muslim geographers added to the subject and prepared manuscripts on geography. One Muslim geographer explained the formation of mountains by folding, sculpturing, erosion and weathering. These Muslim travellers went to China and Japan in the east and to Sicily in the west and gave descriptions of their travels in the form of stories and essays among which stories of "Arabian Nights", "Sindbad the Sailor" and "Four Darveshes" are very amusing and full of information. In the early 9th century Caliph-Al-Mamun of Baghdad encouraged geographical and other kindred studies. Mohammed ben-Musa, Librarian of Baghdad, compiled a description of the earth. A more important figure was Idrisi (1099-1154), an Arab of Spanish birth. He substituted projections by dividing the inhabited world into seven climates or zones between the equatorial line and the arctic region each of which was further divided into eleven equal parts by perpendicular lines.

At the end of the 13th century, trade relations of the Christians and the Muslims became wide-spread and established, and the knowledge of an individual about the world was much enlarged as compared to that of the Greeks. We have seen that the classical period was marked for the development of descriptive geography, expressed through stories, descriptive passages and poems. During this period, the church was considered to be the most powerful instrument of education and hence missionaries began to move about spreading religious teachings and education. The existing Arabic literature on geography was translated and studied by these western missionaries. The year 1453 was a landmark in the history of geographical development when the Greeks were driven out of Constantinople by the Turks. Geography as an independent subject had no place in the curriculum. Therefore, geography was defined by these geographers as the description of the earth.

II. Sailor Geography

The Renaissance marks another step towards the making of modern geography. During this period, ranging from the 14th to the 16th century, great discoveries and explorations had taken place and, therefore, the knowledge of geography acquired a practical outlook. This era saw the beginning of maps and map drawing.

The first traveller whose journeys resulted in a noteworthy addition to the knowledge of the Mughal Empire was Joannes de Plano Carpini, an Italian of Umbria. Bacon revived Aristotle's concept regarding the spherical form of the earth. Next came Marco Polo, the greatest of all eastern travellers of this period, who accompanied his father Nicolo and his uncle Maffeo in their journey to China. Polo was the first traveller to trace a route across the entire length of Asia naming and describing kingdoms he had seen.

Prince Henry, surnamed the Navigator, (1394-1460), fifth son of King John I, was a great personality of his age and was known as the maker of geography. He gave instructions in cartography and astronomy to sailors and seamen through Arab teachers who did much to spread the knowledge of geography.

When the New World was discovered by the Portuguese, they tried to map it out. New routes leading to the East and to the West Indies were found out. Germany also became a central institution for the development of mathematical and descriptive geography. The first English geographer who wrote a scientific volume of geography was one Mr. N. Carpenter. Prior to the 15th century, geopraphy occupied a very subordinate position in the school curriculum. In the 16th century, it was Sir Thomas Elyot who gave added life to this subject by preaching that geography broadens the outlook, enlarges imagination and quickens the senses. He, therefore, laid special emphasis on the use of pictures, plans, and maps in the teaching of geography. He was not satisfied merely with this and replaced modern languages by a study of maps and astronomy in the school curriculum.

We have seen hitherto how the age of discovery and exploration inspired explorers to leave their homes in search of knowledge and explore new lands. Newly-found out coasts, lands and seas had to be mapped. All this formed part of a new phase in geography—Sailor Geography. This followed the Capes and Bays method of teaching which meant memorizing geographical facts. In the 17th century, geography was included in the school curriculum because of its practical utility in navigation.

III. Physical Geography

The rapid development of science in the 19th century and the rise of material prosperity compelled educational authorities to teach science in schools. This was due to the wide knowledge of the people gathered through the works of scientific explorers like James Cook, Humboldt, Wallace, Columbus, Vasco-de-Gama and Magellan. This additional knowledge led to the birth of other sciences like Physics, Chemistry, Astronomy and Geography. From these new sciences, there emerged a hotch potch known as Physiography. Thus geography broke up into a number of sciences. This led to the study of Physical Geography which meant a systematic treatment of the earth features and their relation to one another without their bearing on human activity. Herein facts were arranged in an orderly manner and the subject was correlated with other subjects. Naturally, geography began to be included in the syllabi of various universities. The University of Paris was the first to have a chair in Geography. It was Karl Ritter a German professor of geography who presented the subject *as a bridge between physical sciences and humanistic studies.* He also emphasized the correlation of history and geography. As a result, geography came to occupy an important position among school subjects. Geography was defined as the Science of Distribution.

IV. Human Geography

Sometimes later Physiography began to be felt as having a human side as well. So much so that geography was better known to be the science of man on earth because of the significance of geographical environments on the economic activity of the people. It was considered that clothing, food, shelter, profession, social laws, customs, superstitions and festivities of the people are all determined by the geographical environments in which they live. Geography was then known as a science which dealt with the influence of environments on the life of man. This definition stressed on the supremacy of nature on mankind and that man must obey nature. In the course of time this definition had to undergo a change and Geography was no longer considered to be a science of man on the earth but indeed a science of man on earth studying the action, inter-action and inter-relation between man and nature. It was considered that man's life was, on the one hand, dependent upon his environment, and on the other hand, natural features get modified by man's action. Though no man's life is wholly dependent on his immediate surroundings yet the entire human life is to be treated as a adaptation to the geographical environment. This gave rise to a more convincing and acceptable definition that the function of geography is to train future citizens to imagine accurately the conditions of the world stage and so to help them to think sanely about political and social problems of the world.

This definition lays proper emphasis on the controlling power of nature. It studies the active part played by man on the world stage and the efforts he made to change the setting of the world stage of physical environments.

Subsequently, an attempt was made to show how the two extreme views of determinists and possibilists could be integrated to solve the problems of human geography. It was agreed upon that neither the geographical environments nor man's conquest of nature itself could explain cultural advancement though the influence exerted by immediate geographical neighbourhood was greater and more pronounced. It was also agreed that though physical factors influenced customs and social organisations but there were other non-geographical factors like religion and inheritance, etc. which contributed substantially to the final shaping of society and culture.

In the course of time the human geography began to be examined in much greater detail with particular reference to the physical setting and social traits and with a view to analysing the influence of geographical environment and the resultant salient features of human adaptations. Thus the geography of settlements, both rural and urban, ushered in, with the advancement of human geography. The settlement geography deals with the geographical study of origin, growth and distribution of rural and urban population. Today geographers are conducting urban geographical research and are helping in town planning. The genesis, social traits and the cultural life of the population depend on the exploitation of resources available to man. Attempts have also been made to correlate physical environments with crime and civil litigation. Generally speaking fertile lands produced more of criminal litigation while dry lands more of civil cases. Recently socio-geographic surveys have been conducted to study the impact of changing social, economic and political factors in bringing about variations in the distributional pattern of settlements because every phenomenon involving man, his habit, and natural resources has some geographical aspect. The geographical situation of a country in relation to other countries of the world plays a decisive role in the composition of its population and the ultimate political set up in the country.

2

Modern Concepts of Geography and Geographical Techniques

Geography has had a very chequered course of development. It passed through different phases of rise and fall and at every new stage the concept of geography underwent a change. The evolution of geographical thought and concept took place during the age of discoveries and explorations. The ancient Egyptians, Babylonians, Phoenicians, Greeks and Romans made valuable contributions to geographical concepts during the sixteenth, seventeenth and eighteenth centuries. More and more geographical concepts developed as geography gradually emerged from a descriptive approach of the classical times to analytical approach of the present times. The geographical discipline is currently overflowing with a number of concepts and there are as many concepts as there are branches of geography. Recent years have witnessed the greatest innovations in the various fields of geography due to its new concepts and techniques. It appears that some of the concepts of geography were already in existence for a long time ; perhaps what has been done in recent years is really a codification and explication of the existing concepts. Geography today consists of a number of well-defined generally accepted conceptual elements accompanied by a wide range of methods, techniques and tools capable of presenting and analysing data from different perspectives.

The most widely recognised concept of scientific geography treats the world as essentially an abode of man and solving national and international problems. The perspective of the present day geography is as wide as the earth, as large as the life itself. In a broad way we can conveniently say that the subject matter of geography is the earth, not only the rock or the water that encircles it, or the universe, or the man that inhabits it, or the atmosphere that surrounds it, but it studies one and all. It is because all these have a direct bearing on one or other and have a particular meaning to man and, therefore, a need was felt to develop the concept of 'applied geography'. This is why geography for school purposes studies the earth as the home of man. The human aspect of geography has been lately recognised because of the great revolution in educational psychology. Today we are more concerned with the needs and interests of the child rather than with the academic demands of the subject. The child has to live in a world of diverse things and events where various human communities are settled. He has to pass his leisure within these communities and establish contact with them. Since no man can live by himself and no community can live in isolation it is natural that the pupils should know what each community is and what its political and social aspirations are. The aim is to make the child interested in man and his world problems so as to make him a true citizen not only of his country but of the wider world because the man of today is a citizen of the world. Education is to provide him with opportunities to exercise his intelligence, widen his vision, develop his imagination, sharpen his judgment and quicken his sensibilities so as to study the conditions of the world and think sanely and act wisely in regard to social, economic and political problems of the world. The discipline of geography is more concerned with studying of world and its inhabitants and their interrelation and inter-actions. Hence for school purposes we shall define geography as 'the study of the peoples of the world.'

Modern geography is now considered to be a separate science requiring a detailed study of the territories of the world. Its instrument of study is the map. Like any other science it follows a scientific course. The geographers of today are now increasingly concerned with understanding process, patterns and structure and examining geographical data by techniques commonly used in other school disciplines. The integration of natural environment with man's social achievements and their expression on the landscape is the field of geographical studies. We live in the age of social and technological revolutions in which man's ability to harness the stock of nature is increasing at the rate which his ancestors would have found frightening. The geographers of the past had long been concerned with the study of nature on the one hand and culture on the other hand but the interaction between the two had mostly remained side-stepped. The time has now once again come for geographers to interpret the relationship of natural resources and activities of man and their inter-action. This is why modern geography is defined as a unifying science, the raw material it deals with is derived largely from other sciences and studies, it deals with the material in its own way seeking and discovering the inter-relation of phenomena and the interaction between man and the phenomena. This concept of applied geography is of great significance in developing universal brotherhood and offers a scope for geographical techniques of survey, analysis and synthesis for the solution of practical problems in the modern times of planned development.

The introduction of statistical techniques has proved very useful for carrying out researches in physical, economic, human and regional geography. The land use survey is a technique adopted by geographers for study of agricultural regions. The statistical technique has also been gainfully employed for determining the indices of crop concentration, crop distribution and crop diversification as well as for determination of regions based on these indices. The functional zones of a city are classified on statistical method and also on Kneedler's method. Based on statistical technique, the geographers have evolved a technique of measuring the pressure of population on food resources. The technique of land use survey, which is also based on statistical technique, has been adopted by geographers in different countries to bring about an improvement of the social services and understanding the processes of economic, regional and social development.

The modern technique of teaching geography is based on the concept of region as one of the dimensions of development planning. Every region has its distinctive land use, structure and the resultant mode of life. The problems relating to regional study of geography are terminology, delineations of the region, approach and methods of delineations of regions at different area levels. The technique of regional geography emphasizes the need of the statistical method before undertaking field work on the aspects of landscape, land use, rural and urban settlements and their developments. It further lays stress on the need for collecting all published and unpublished data, preparing maps and questionnaires and tabular statements before undertaking field work on geography and geomorphology and other aspects of physical and economic geography like landscape, land use and human occupations. It may be pointed out that the technique of regional geography is based on three types of regions, natural cultural and geographical. The essential character of the region is the adjustment of human groups to the geographical environments.

In recent years some new fields of theoretical geography have been tackled with the help of metageography which is concerned with the notion of geographical space. Metageography is a study of the fundamental principles common to all other sciences and on which the geographical laws are based. The geographical space is a region comprised of a complete system of all the geographical elements taken together of a region and possessing attributes of its own within the universal space. Metageography is thus concerned with the study of the general law of development of geographical space.

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Scope of Geography

Geography is an old field of knowledge known to the scholars of the ancient world. Its field of study used to comprise brute facts and a good deal of slip shod superficial work was taught in the name of up-to-date geography. There was a plea for widening the scope of study of geography particularly in its relation to other allied subjects. Initially the progress of modern scientific geography was very slow but in the recent past there has been a rapid growth of the subject due to strong stimulus given by geographical research. It is now being developed as an inter-disciplinary subject and serves as an important link with both the humanities and social sciences and plays a vital role among the physical resources. It aims at nothing less than an understanding of the inter-action of the vast natural environments on the surface of the earth on the entire humanity. Its study covers all the phenomena on the earth's surface and explains the principles of day and night, seasons, climate, surface forms, river erosion, flora and fauna as well as distribution and development of varied human communities. Geography has thus ceased to be a mere collection of meaningless facts to be learnt by memory and reproduced when required.

Geography today covers a vast field and comprises many branches of scholarship in its fold. Like the bee it sucks honey from every flower. Its subject matter consequently lends to and borrows interest from both scientists and students of social sciences, as it includes physical sciences like physics, chemistry, mathematics and astronomy on the one hand and natural and humanistic studies like botany, zoology, anthropology, sociology and history on the other. Geography trespasses into the domain of other subjects and at times it was held that it had no independent existence. This charge would have been correct a century ago but not today as the subject of geography has undergone a radical change. Geography, like any other science derives its raw material from other sciences and it employs the derived raw material from its own angle and in its own manner. Every science studies some part of the universe and examines it from its own point of view. Astronomy deals with stars and star system and history studies human groups ; whereas geography has its unit of study the regions of the world. Each unit though interlinked has its own peculiarities. Thus geography studies the principles of unity in diversity and vice versa. The geographer studies each region and tries to put forward geographical explanation for its conditions and life as a whole. The geologist, the meteorologist and the botanist study the same region from their respective angles. Each specialist confines himself to one aspect of the region and leaves the rest to be explored by others. The difference being, that while the specialist follows his own thread in its diverse designs, disects it and sets apart from its knotty interweavings with other threads, the geographer studies the intermixing of all the threads and patterns which result from his own art of knitting with different threads. Geography thus takes a very wide outlook and tries to interpret the action and interaction of all physical factors in relation to the intricate problems of the life of man on the surface of the earth. There lies the utility of studying geography because the discipline of geography brings us into contact with the action of the living man. It brings within its field of study every form of human occupation and every effort directed to harness nature for the progress and development of mankind. Geography is now-a-days considered to be a distinctive discipline able to take its position at par with the physical sciences and humanities in terms of current innovations. The scope of geography has become so vast and complex that a need has arisen for specialisation. As a result, the subject matter has broken up into a number of branches as shown below :

1. *Physiography* : This branch studies relief, soil and structure of the earth. It is the source for the other branches and is, therefore, the most important branch of geography as the whole superstructure of the discipline of geography is built upon it. It splits up into a number of sub-branches making the subject matter of geography most comprehensive but at the same time immensely interesting. Some of its important branches are Geomorphology, Glaciology, Siesmology, Hydrology, Climatology, Pedology, Biogeography, Medical geography and Palaeogeography. Geomorphology studies the earth's structure comprising various types of rocks, mountains and their evolution and it receives inspiration and guidance from the works of geologists. Its study comprises dividing a country into physiographic regions. For instance, India is divided into seven major physiographic divisions :—

(1) North Mountains,
(2) Great Plains,
(3) Central Highlands,
(4) Peninsular Plateaus,
(5) West Coast,
(6) Central Highlands and,
(7) Islands which are divided into 20 sub-divisions and 62 physiographic provinces.

Glaciology is concerned with the study of glaciers. In India glaciers originate only in the higher altitudes of the Himalayas where there is perenial accumulation of snow above the snow line which is situated above 4500 metres. Geographers are also interested in the study of the effects of earthquakes on topography, drainage, and human habitation. The causes of earthquakes and their bearing on the interior structure of the earth are dealt with in the science of Siesmology. The hydrological characteristics of rivers, lakes, fluvial morphology, peculiarities of flood genesis, fluctuation of water table and underground water resources, genesis of coastal features and many other hydrological problems are the domains of Hydrology. Thus it includes study of springs, lakes, rivers, flood control and underground water. Oceanography is another branch of Hydrology. Climatology is not a new science in India. The study of causes and distribution of temperature and winds, rainfall and runoff, weather and climate fall within its fold. Soil, which sustains life both of the plant and animal world, owes its essential properties to complex physical and chemical reaction of parent material by climate, vegetation and topography, etc. Thus geographers alongwith chemists, geologists and biologists feel interested in the study of soil science called Pedology. Biogeography studies plant geography and zoogeography. Unfortunately this branch has been neglected by geographers because of lack of interest of botanists and zoologists in the distribution of flora and fauna. Since all kinds of diseases, infections, parasitic or organic are a product of the physical environment, geographers are getting interested in geo-medical problems. Physical geography in the past geological ages is a subject matter of paleo-graphy. It studies the distribution of land and sea through successive geological times. In fact some branches of physical science like pedology and geomorphology that have a direct bearing on the every day life of man are receiving increased attention from geographers and as a result new branches of geography like, geography of soils and physical geography have emerged out.

2. *Economic Geography* is concerned with the production and distribution of the raw materials in the country. The internal, external and international trades come within its domain. It studies the influences, both physical and political, which operate on man's economic life and conditions of development in the fields of agriculture, manufacture and commerce. The study also includes the impact of constructional investment on the socio-economic life of the people. The problems of movement of labour and industrial locations are tackled both by geographers and economists. The location and distribution of mine based raw materials and agriculture-based industries are also some of the subjects of study by geographers. A number of geographers have made a study of the geography of powers which is the basis of all industrial developments. The study of geography of agriculture and livestock is another branch of economic geography. Soil erosion is the greatest single evil to agriculture and animal husbandry. The agricultural practices are usually

dependent on the working of livestock which suffer from under-starvation due to scarcity of adequate fodder resources. This is another problem which attracts the attention of both the geographers and the agriculturists.

3. *Human Geography* : The subject covers the evolution of mankind, its different races, their distribution and man's adaptation to environments. It is an established fact that no man's life today is tied up completely to his immediate surroundings and that all human life is to be treated as a partial adaptation to the geographical environments. The influence of environments on the mode of life is a subject in which geographers are as much interested as the anthropologists. The geography of population studies the various causes of regional variations in population distribution. Settlement geography deals with the size, form and functions of settlement built up by man and analyses their historic growth. The study of urban geography has started engaging the attention of the geographers and urban geographical research has been undertaken by individual geographers. In the field of human geography there is less of the theory of environment determinism. It is widely accepted today that it is not the physico-biological environments alone that determine man's ability to make the best use of the natural resources around him but the philosophy of life and technical skill that he has acquired are the main determining factors.

4. *Political Geography* : This branch deals with the government of states and countries. Geography had its birth in the research of finding out the relation between man, his physical environments and the state to which the individual belonged. This gave birth to political geography in Greece, Great Britain, U.S.A. and Germany. It is the least developed branch of geography, though there is more than ample scope to expand its horizons.

5. *Geography* : This term is applied to all processes of surveying and map-making. This branch is responsible for geodetic and topographic surveys and preparation of maps on certain scales. It is a useful branch but there is not much scope for research by geographers. It has as its subject-matter the earth as a planet.

4

Function of Modern Geography

The importance of geography is, by and large, getting recognition in modern times as its study has proved useful in many ways. Its study helps in the assessment of agricultural productivity, regional planning and economic rehabilitation as well as in the preparation and execution of projects in relation to economic growth and social welfare of the country. Its utility has been felt in economic research institutes and planning organisations as its study determines the relationship of resources and activities with land and social goals. Geography provides useful basic material for the techno-economic surveys which are undertaken to make an assessment of development potentialities of the resources of different states. The successful execution of these surveys depends on the data collected on physical features, climatic conditions and distribution of natural resources like land, rivers, lakes, agricultural co-ops, forests and minerals. These surveys are, meant to show the distribution of resources in relation to physical and climatic aspects of regions and to determine areas where improvement could be possible.

Geographers are making valuable contributions to the study of both rural and urban settlements, as there is a considerable scope for the application of geographical knowledge in the study of urban problems. The services of geographers have been secured by the Town and Country Planning Organisations in various countries to study the past and present trends of urban structure and distribution and their findings have proved very useful for purposes of providing amenities to the city dwellers. In India geographers have started undertaking the study of detailed land-use of the urban areas for proper demarcation of residential, commercial and industrial areas. The services of geographers have also been secured in preparing master plans for metropolitan cities like Bombay and Calcutta where the geographers have made a study of all the physical phenomena in the background of the existing development. The pressure of the growing population on land resources is being felt practically in every country of the world. This has demanded a survey of the land-use so as to avoid the misuse of lands and to put the idle land to some use. In India an attempt has been made in this direction by preparing a land-use map of the Damodar Valley following the pattern of the land-use map of Great Britain prepared by Dr. Dudley Stamp.

Today the knowledge of geography with all its accompanied methods and techniques is increasingly employed in solving many of the national problems all over the world. The problem relating to floods and draught is the greatest of evils. Though floods cannot be prevented yet flood losses can be reduced and the damage done by floods can be properly assessed by studying their after-effects like the intensity of flood, extent of submerged land, the velocity of the current, the erosion of land, and deposition of sediments. This study will help to minimise damage done by subsequent floods.

The knowledge of geography can be of immense value for planning the economy of a country on a regional basis. The contributions of geographers in the field of thematic mapping of natural conditions, resources and economic factors for the benefit of developing countries have been well recognised. Through these maps there is a good possibility of making valuable contributions by geographers towards planning for the development of available resources in the under-developed countries. Whereas the developed nations have grown extroverts, the developing countries are in danger of becoming too introverts. By seeking first-hand information about other nations and their problems the geography student's vision will be much broadened having been directed beyond narrow national boundaries.

Geography has a utilitarian value in so far as it elucidates and reinterprets the complex relations between the physical environments on the one hand and distribution, mode of life and economic and social activities of man on the other hand, both in the present and in the past. The aid which geographical research can render to allied subjects like history, economics, sociology, commerce and agriculture, is invaluable. No study of these subjects can be complete without reference to geography. In the present era news is of vital importance even to a man in the street. Places mentioned and problems involved have great geographical importance. Therefore, a fuller comprehension of the news depends on the geographical background of the reader. Geography has an educative value. More than anything else, our students should know all about the natural resources of their country and of other countries coming in contact with them so that they may, when their time comes, contribute their proper share to the regeneration and development of their motherland which has vast potentialities. Even then weather and climate of a country are poorly understood by many of us and we are greatly handicapped due to lack of geographical knowledge. The study of geography broadens the mental outlook of the pupils and enables them to offer a critical attitude toward world problems. Their innate capabilities, powers of observation, imagination, thinking and reasoning are developed to the fullest extent. In some ways, the knowledge of geography is essential for successful execution of war, for the geography of belligerent countries is a director of all land, sea and air operations. Even the defence preparations are controlled by the geography of the land.

Geography can bring about a closer co-operation and better understanding among the nations of the world. Geographers, whether engaged in teaching or in the research institutes, have been making valuable contributions to the cause of upgrading of developing countries. In fact a large number of geographers of the world are actively engaged in geographical research on developing countries. The regional variations in the physical features have given rise to regional variations in the field of cultural landscape and in the different ways of living and thinking. The world of today has been divided into three economies based on realities affecting mankind today.

1. *Developed world* is comprised of 24 countries of which 18 are in Europe, one in Asia, i.e. Japan, one in Africa (South Africa) and two in the new world i e. U.S.A. and Canada and two in the southern hemisphere i.e. Australia and New Zealand. These developed countries are today the leaders of the world in different fields of learning and human venture and constitute the first world.

2. *Socialist world* is comprised of a group of seven countries in Eastern Europe namely, of U.S.S.R., Poland, German Democratic Republic, Czechoslovakia, Hungary, Rumania and Bulgaria. These countries had to make a tremendous effort to develop their economy under a new socio-political set up. U.S.S.R. ranks second to U.S.A. and the remaining six countries stand midway between the developed and developing countries. The Republic of China though a part and parcel of this world, has separated in the recent past to form a fourth world of its own.

3. *Developing world* is spread over three continents and covers practically the whole of Africa except South Africa, the whole of Latin America and about three-fifth of Asia. Thus they cover one half of the land area and almost the same extent of population of the world. All these countries used to have very highly developed civilizations at a time when the other countries were passing through dark periods. Once upon a time, the Indians, the Chinese and the Arabs enjoyed unprecedented glories as compared to the so-called developed nations of today. Gradually they became depleted due to exploitation by foreign rulers. After having attained their independence in recent years they are making every effort to cast off their scars of under-development.

The regional variations in the physical landscape has also given rise to unequal distribution of opportunities and as a consequence, some parts were more favourably situated for development of economies than others. The momentum so gained by the favoured parts have widened the gulf between the developed and the developing worlds. The developed world is a region of riches and surpluses due to untiring efforts of its people. The developing world has remained a region of poverty and scarcity either due to helplessness of its people or due to lack of opportunities as a result of foreign domination or due to lack of their own initiative. It may, however, be understood that this division between the developed and the developing world is only man-made and not a creation of nature and has to be broken sooner or later. It should be the concern of both the worlds to make sincere efforts to break the artificial boundary which keeps the two apart. This approach among the nations alone can bring about a global peace on earth and will minimise armed conflicts which generally originate in the lands of scarcity and hunger. In fact, many such incidents have taken place in the developing countries in recent past and they could have sparked off a nuclear war. It is as much a concern of the geographers as of the economists, sociologists and political leaders to bring about an understanding among the nations of the world and to devise ways and means of solving problems of economic planning which confront the developing countries. The geographers of the world should aim at spreading the right type of geographical knowledge. There are a few research institutes in foreign countries where the specialists are engaged in gaining more and more geographical knowledge about the so-called backward countries. The contributions of these geographers should be utilised by the economists and others who are responsible for the economic development of the world.

5

Aims and Objects of Geography Teaching

The question of aims and objects of teaching a particular subject should be the first to occur to a conscientious teacher because the objectives of teaching a subject strongly influence the organisation of the curriculum and at the same time provide guidelines for the methods of its approach. Geography teachers have lately recognised the necessity for sound objectives in curriculum planning.

Objectives are usually governed by the needs of the young pupils and these are of two types. Firstly, those which can be satisfied by acquisition of ideas and skills and are known as short-term or subject-matter objectives. The second type of needs are those which are satisfied by matured thinking and acting. The latter are summed up under long term objectives, because their function is an overall development of a person which may continue throughout his life. These two types of objectives are inter-related and inter-dependent. The subject-matter objectives control the frame-work of the syllabus, whereas the long term objectives determine how the course material of the syllabus has been tackled. The long-term objectives in geography will require a child :

(1) to acquaint a basic knowledge of the subject;

(2) to develop his own observational skills;

(3) to understand the inter-relation of the subject and the society, and

(4) to infuse thorough understanding of its concepts and theories.

These long term objectives aim at providing young pupils such types of knowledge, skills and attitudes as would develop an acceptable behaviour in a democratic society in which they live. In other words, it means continuation and expansion of ideas initiated in the elementary classes till the end of the schooling. The geography teacher is as much responsible for the achievement of these goals as the teachers of art, science and mathematics. In fact, it is the joint responsibility of the entire staff engaged in teaching.

The subject-matter objectives are transitory and may be for a specific purpose. It may be achieved in a particular lesson or in the course of the academic year or it may be prolonged to the whole period of schooling. The main purpose is to give continuity to the process of teaching of the subject from lower levels of schooling to the higher secondary levels. The main obstacle in operating these types of objectives is that the pupils are apt to disown them. Firstly, because only a few of them have a real love for learning for its own sake and secondly, they set up their own objectives. This happens particularly during adolescence which is the most difficult period for boys and girls. Adolescents tend to be more and more aggressive and are not keen to remain under the control and supervision of elders and they often refuse the advice of teachers and parents as a rebellion against the ways of childhood. The matured boys and girls are likely to be conscious of their limitations but ignore their real strength and instead, want the status of adults and approval of their fellow beings. Teachers can help them to overcome their weaknesses and to compensate them for their shortcomings. In such circumstances, it will be ideal for a geography teacher to set up such subject-matter objectives which are parallel to objectives of his pupils so that they may readily accept them. The teacher should sublimate the insincts of the adolescents to enable them to satisfy their objectives so that ultimately they may adopt his own objectives by gradually making them conscious of their subject-matter learnings.

It is unfortunate that most of the teachers are not aware of the goals of general education and, therefore, they fail to realise how much each subject can add to its particular value to the curriculum and thereby can help the young people to achieve the goal of education. As for instance, mathematics encourages accuracy and classics develop logical thought. In discharge of his responsibility the geography teacher should understand some of the goals of his subject as given below.

The aim of teaching geography is that it provides mental discipline which means that the subject trains the pupil's whole mode of thought which in its turn influences his intellectual life and studies in the same field. This mental discipline comes through the application of scientific attitude in distinguishing facts, interpreting their effects, and drawing correct conclusions and inferences. Geography encourages independence in thought and action. An independent person will come to his conclusions only after thoughtful deliberations. He will not deny authority rebelliously but will adopt reservations in blindly accepting the opinions of others. He will investigate and evaluate statements of others against factual data. Geography teachers are in an advantageous position to develop this type of thinking by encouraging pupils' participation in the learning process. Geography also broadens the mind and stimulates imagination with the information it gives. It encourages travel. The knowledge so gained from travelling will help pupils to meet the problems of every day life. Most of the problems are social in character and the knowledge of geography will give them training in solving problematic situations arising in their daily lives.

Geography has another special function to perform. From one's study of different people of the world one knows the contributions of each nation towards world culture. He also realises the interdependence of mankind. Thus a sympathetic attitude is developed among pupils when they find similarity of needs all over the world. It further explains to them that the differences in the physical character of the people of the world is due to variations in their physical environments. The pupil also realises that it is not possible to maintain the same standards of comfort all over the world, and that it necessitates living on a basis of international co-operation and understanding. Thus geography lays down the foundation for a solution of the economic, social and political problems. Wars are the result of ignorance about people in foreign lands which results in narrow regionalism. Knowledge of geography bridges the gap and helps in avoiding conflicts by bringing about international understanding. On the material and practical side too, the subject of geography has some significance. The advancement of a nation is measured by the services it renders to other nations. The improvement of the lot of backward nations and the profitable utilization of the increasing amount of leisure in the advanced countries are some of the problems that the world faces today.

A student of geography can appreciate the beauty of nature better which might cultivate a sense of responsibility for its care and protection. The study of natural landscape may become a good pastime with him. Geography has a cultural aim too. Culture is the sympathetic appreciation of the universal truth expressed in art, literature, philosophy, science and religion. It sharpens man's instinct to know the unknown, to see the unseen and to fathom the unfathomed. Geography helps developing hobbies and a taste for reading newspapers and literature on travel.

Geography helps pupils appraise their real worth to them. Every person, no matter what type of intelligence he possesses, has a place in the society. It is good for the society to keep persons of different skills and calibres. The geography teacher should help his pupil to discover his latent qualities, take pride in his talents and build his character to enable him to find satisfaction in his achievements.

The instinct of love is inborn in a human being. In order to create a desire in a child to serve willingly his country and his fellowmen, the teachers should sublimate this basic instinct. The first requisite of creating love for one's country is to make him know it thoroughly. The teacher of geography should lay honestly before him the interests, aspirations and traditions of his country. Let the

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child feel the political, social and racial ties of his country from study of books, direct observations and experiences. He should make a dispassionate study of geography in a way he is least prejudiced by the writings of the press or the words of the leaders. He would develop a constructive attitude towards all that concerns his country. In this manner, the teacher can direct the child towards the right path and convey the true meaning of the word 'Citizenship'. A child's mind is fresh to receive instructions right from the start. Whatsoever is imparted to him at this formative stage, it is permanently stamped. The teacher should start imparting such lessons which will make him interest in his surroundings. An intensive study of the local region can give substantial training for his future tasks that he would come across. This training in good citizenship will make the pupil realise that it is within man's power, by his continuous and untiring efforts, to control nature. The child becomes conscious of the fact that he is not merely an on-looker of the worldly drama but a principal actor on whose contributions, based on intelligence and skill, depend the destiny of civilization.

The purpose of general education is that the students should employ sound thinking habits in meeting situations arising in the daily walks of life. They should be able to display attitudes of tolerance, truthfulness, sincerity and integrity. They should also recognise their place in society and should develop a personal philosophy based on truth, logic and understanding. They should develop and enjoy personal interests and natural man-made environments. They should base their opinions, decisions and actions against the background of principles and store of knowledge. The aim is to train the future citizens to imagine accurately the conditions of the great world stage and so to help him to think sanely about political and social problems in the world around him. To the attainment of this highest objective of general education, the subject-matter objectives are the necessary stepping stones. While the educator has his eyes focussed on the ultimate aim of education, the geography teacher should give his contributions towards the realisation of the primary aim of education by taking such measures as might ensure sound factual knowledge, a clear understanding of factual relationship and a keen discipline of intellectual powers.

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Correlation of Geography

Reviewing the stages of its development one would come to know how geography gained importance among school subjects. At one time it was supposed to serve other subjects like a faithful maidservant. Later on, it was included in the syllabus for some specific reasons and thus gradually it earned an important place for itself in the school curriculum.

Today geography is a link between the physical sciences on the one hand and the social sciences on the other. Consequently, it stands midway between the two. It is considered to be a liaison. A large part of geography is a natural science and the remaining part is a social science and the two are closely inter-related. Because of its relation with the social and the natural sciences, it equally appeals to a scientist and to a student of social sciences. The geography teacher should bring home to the pupils the inter-relation of the two. Modern geography focuses attention on man s physical, biological and cultural environments and on its relationship with his environments. Thus it covers all the subjects within itself. As a result it renders valuable help to the interpretation of other subjects by preparing a very wide background. No study of history, economics or politics is complete without reference to geography.

In this material world education always lends itself to respond to certain important happenings that may take place in a given period. Since the subject of geography is very intimately related to most of the elements of the earth, its response to them is the greatest of all the subjects. It follows that geography is an important constituent of school curriculum. It is desirable then that the subject should be correlated with other school subjects. Another modern trend in the educational field is specialization, both in the subject-matter and in the methods of approach. The one great demerit of specialization is that knowledge is confined to water-tight compartments. Geography comes to the rescue of this drawback by acting as a bridge among different subjects. A geography teacher' can very conveniently talk in terms of history, politics, economics, science and fine arts, provided he has made a thorough study of geography. Geography cuts across every school subject and enters into every other form of the curriculum. To teach geography without its correlation with other subjects is meaningless.

Geography and Mother tongue : Geography provides many chances for exercises to be written in the mother tongue. The geography teacher should aim at having pupils' note-books in a language which is clear, correct and to the point. He can lighten the burden of the language teacher if he devotes some time to the correction of their language mistakes. Besides, literature on geography is best appreciated in the mother tongue. Similarly, the language teacher helps a lot by setting geographical topics for story, essay writing or composition, etc. Even passages for precis-writing may be related to geography. There are very lucid descriptive passages in prose which can be employed by teachers of both the subjects to break the monotony of daily routine. Even geography and language answer-books may be inter-changed by the two teachers. Books dealing with travel, exploration and discovery may be encouraged for language study. When such books are read to pupils, they bring about better linguistic development as well as better acquisition of geographical knowledge.

Geography and Mathematics : It is a common demand of the educationists and the parents that education should be useful to life. This, in other words, means that problems that we set to the pupil should have a bearing on his life. Besides, a mathematics teacher has to give sufficient practice for the thorough understanding of a problem or a formula. How best it would be if the data for drill work is derived from the subject of geography ? A mathematics teacher can find very useful data in geography because the idea of quantity enters everywhere in his study. We always study in quantitative terms the topics on population, production and distribution of animals, crops, minerals and the volume of trade. Again, geography problems may be used for mathematical and algebraic lessons. Sometimes geographical solution has to be sought for work in graphs. Similarly, knowledge of geometry lays down a strong foundation for surveying and cartographical work in geography. The geography student has to draw maps and diagrams at every step to illustrate his points. Besides, the teacher too employs graphs, charts and statistical diagrams as the means for teaching geographical facts. Naturally, these can be best understood with a knowledge of mathematics. In this connection it may be suggested that we have a special branch of geography known as mathematical geography.

Geography and History : Geography and history are, of course, most intimately related. In fact they are twins, one stresses time and the other space. History studies people of different times and geography deals with the people of different places. Therefore historical facts can serve as a good basis for arousing interest for geographical studies. Similarly, geography offers explanation for historical actions of mankind. The geographical phenomena have a profound influence 'on the course of history' ; historical studies devoid of geographical background would be inaccurate and unscientific. World is a stage on which man plays his part. Geography studies the world and history the action of the man on the world stage. For example, the expansion of the French and the English colonies in North America was directly controlled by geographical setting of the land. The whole story of their colonisation becomes intelligible when geography and history are studied together. Pupils will come to know why the French settled along the line of St. Lawrence because that was the only river that they could find that would lead them into the interior. On reaching the region of the great five lakes, they spread to the west, north, and south by cultivating friendship with the Red Indians, who led them to the Gulf of Mexico by following the course of the Mississippi river. Similarly, the growth of London, Delhi or Lahore can be understood better by studying both history and geography. Ottawa and Washington are not necessarily the most suitable capitals for Canada and U.S.A. ; their importance as administrative centres is very largely historical. The nomadic habit of the desert people is also due to the geographical factors. Germany and France are hostile to each other because of the existence of the river Rhine and Lorrain coalfields as the bone of contention between the two countries. Lastly, both history and geography have a common claim on the equipment of the geography room and on the aids to teaching, i.e. maps, pictures and atlases, which are useful in the teaching of the two subjects in equal measures.

Geography and Arts : Even practical arts are correlated to geography. In a manual class pupils may prepare almirahs, map-holders, and map-stands, thermometer cases, pointers, map screen, cup-boards and other articles for storage and exhibition and also models of the means of transport. In a book-binding class, map repair work may be included. School gardening may explain the cultivation of agricultural crops and forests grown in different parts of India. In a painting class pupils may be asked to draw geographical scenery, e.g. deserts, glaciers, rivers and forests, etc. Drawing helps a great deal in making maps and statistical diagrams.

Handwork and Geography : In modern times handwork in one form or the other is becoming a popular subject because of its great utility in child education. It is now agreed upon that manual skill acts and reacts very favourably on the intellectual faculties of human beings and is a sure aid to human development. The main purpose of including handwork in geography is to train the eye to accuracy and rapidity in observation. Such correlation will render the hand a very useful servant of the brain. At the same time it develops the latent powers of the mind. It will also inculcate habits of neatness, orderly arrangement and accuracy in observation and measurement. These habits will be of great use in the after-school life of the child. In this way the correlation provides a training for good citizenship. Each subject extends a helping hand to the other. Sometimes geography may serve the purpose of handwork and at other times handwork may function for geography. The project method is based on the principles of correlation between geography and handwork. Some topics in geography can prepare the ground for some manual work, while a manual worker carrying on some manual activity may indirectly gather geographical information. There can be many geographical studies arising out of handwork. When wood is used as a material for handwork, an earnest manual worker will have to study the different varieties of timber, the place of growth, the climatic conditions under which they grow, and their ports of shipment. It is pure and simple geographical knowledge. Similarly, a school garden offers excellent opportunities for geography lessons.

Material for Handwork : There is a great variety of material which can be employed for geographical handwork. For younger children up to the age of 12 years, paper, clay, card board and light wood work are recommended. On the other hand, senior pupils may take up work in wood and metal.

Important Principles : The following are some of the principles to be borne in mind in geographical handwork :—

1. The material used should be within the pupil's comprehension.
2. It should be harmless and hygienic.
3. It should develop a taste for handwork.
4. It should be cheap and easily available.
5. Pupils should have a thorough study before they actually start doing handwork.
6. As far as possible, it should be pupil's own creation and, therefore, should not be over-directed.
7. If a substitute for some material has to be employed, it should be similar to the original in make and texture.

Types of Handwork : Handwork may assume various forms. It may include hand and eye training and manual training. Hand and eye training means items like paper, clay and card board modelling. By manual training is meant courses in wood, metal and clay such as school gardening, book binding, pottery and enamel work.

Geography and Science : There has been so much correlation between these two subjects that it has necessitated a common teacher for the teaching of these subjects. Lessons on physical geography are better understood by the knowledge of physical sciences. For example, principles of climate, topography, causes of currents and tides, rotation and revolution of the earth, distribution of flora and fauna, the phenomena of earthquakes and volcanoes, weathering and erosion are the topics which are as much related to physics, chemistry, botany and zoology as to geography. Similarly, the whole biological and zoological life is controlled by the chemistry of soil and climate. Nature study, too, prepares the child for geographical work. All these sciences have a common theme with geography—

each studies it from its own point of view. Geography studies the distribution of rocks or forests or animals or men. Physical sciences study these topics, but from different angles and in greater details. Class excursions can also be utilized for nature-study lessons.

Geography and Religion: There is a plea for widening the scope of the study of Geography in its relation to religion as well. There is a close relationship between the two, because geography emphasises the influence of environments on the religion of a country. It is found that a large number of legends and beliefs in any religion are closely associated with geographical factors.

Geography and Newspaper: Lastly we may note that geography is very closely related to current events. A newspaper of today is very much a text book of geography. The current topics have another function to perform in that they give reality to geography teaching. Geography in its part encourages the reading of newspapers and periodicals dealing with world affairs. The news of the day can give a very good start for a geography lesson. For instance, the occurrence of a solar or a lunar eclipse is an interesting topic for rotation and revolution. In this connection it is desirable that the teacher should have an up-to-date knowledge of the world affairs through reading newspapers and books on literature and current affairs. Even wars can be explained by means of geography. All the defence and attack preparations are governed by geographical factors. Many new towns come into prominence because of their important strategic positions.

Geography and Social Studies: The teaching of geography is being correlated with history to the extreme by substituting social studies for history and geography. From the survey of the recently introduced syllabi for social studies it is found that no place has been given for the study of physical and practical geography. Though social studies have a place in the school curriculum but it is universally acclaimed that geography should be retained as an independent subject and not to be a part of social studies. Geography should be taught in all classes of the primary, middle and secondary schools.

It was Herbert who advocated a correlation of school subjects. Since geography can have very wide correlation with other subjects it has some dangers attached to it, for correlation means overlapping when the limit is exceeded. This involves repetition and waste of time. To avoid this overlapping, it is suggested that faculty meetings be held before the beginning of every school term. The geography teacher should always be in contact with the language, history and science teachers. If the same teacher teaches all the three subjects, this difficulty may not arise; otherwise consultation between teachers of allied subjects is most essential to avoid waste of time and labour.

7

Methodology and Methods of Geography

The methodological revolution in geography commenced with the introduction of statistical techniques and since then development upon development has piled. Regarding the importance of methodology it may be said that a methodologist, like any other scholar will be required to carry on his self-education throughout his life because a well-trained methodologist will confront new developments in his science, judge their merits, relate them to past trends and make a reasoned choice as to what he wants to integrate into his own thinking. It may also be pointed out that a meaningful solution of the problems depends on the methods which are available. In other words, it means that if a problem has been unsuccessfully examined at an earlier stage of a discipline's evolution, it should be repeatedly attempted till a synthetic approach has been achieved. With this end in view we should talk about new methodology in geography teaching. A few recent years have witnessed the greatest innovation in the field of teaching methods.

There are four aspects of geography teaching :

1. A point of view built on a distinct methodology,
2. Its philosophy and motivation : know your neighbour and know yourself.
3. Its synthetic approach and,
4. Its regional concept.

The methodology in geography is the chief concern of the geography teacher. There is need to keep ourselves within the limits of geography as far as possible. More and more techniques are being employed and border line branch specialisation is going fast and the danger of overlapping impends. The teacher of geography is advised to make a very careful assessment of the value of every non-geographical material to the geographical argument and should make a judicious use of statistics, which would help prevent loose thinking. Field investigation should form the basis of teaching of human geography because its subject matter lends itself to be taught successfully through indoor and outdoor games, both of group and competitive types. Satisfactory teaching aids such as maps, pictures, films and statistical diagrams should be freely adopted in a geography lesson. The value of pictures is widely recognised and teacher should know to use them in actual teaching. Magic lanterns, slides, film strips are useful aids. The models like the one for demonstrating midnight sun phenomenon is a useful equipment. Thus the synthetic presentation of the complex subject matter of geography depends on the methods like :

1. Observation method.
2. Excursion method.
3. Laboratory method.
4. Project method and
5. Regional method.

1. *Observation method* : A real impression of an object or a plan can best be gained through personal observation because the process of learning consists of two stages :

(a) seeing or doing and

(b) Thinking. Direct experience is an essential step to right understanding.

By observation and action one gains first hand impression of an object. Then by thoughtful enquiry either consciously done or directed by some purpose the first impressions are changed into ideas of the properties of the object. Thus one begins to form a world of ideas from one's experiences. Thereafter by permutation and combination of ideas and by constructive thought one forms a conception of things and events. In the study of geography in particular and other subjects in general, direct experience is the foundation for all knowledge. Consequently experience plays a double role :

(1) as a basis for imagination to work on, as such experience should offer a rich, varied and extensive stock of impressions.

(2) as a basis for the formation of general conceptions which facilitate comprehension.

Therefore, in teaching geography the observation method and exercises based on it must form an essential foundation for a part of learning if not for the whole of it. Pupils should be made interested in local environment by allowing them to go out and to observe the actual processes or phenomena, e. g. the pupils may observe the surrounding rural and urban areas. The information so gathered from the local environments will help to make them understand similar conditions in their own provinces extending to other countries of the world. It is most desirable that the observational work of the pupils be carefully directed and guided by the teacher, because pupils are too young for this direct responsibility. The observation method has a very wide range and can be very conveniently employed.

It is one of the most effective and popular methods of teaching geography.

2. *Excursion method*: An excursion arranged for the study of a part of the country on the spot is the most useful method of teaching geography. Excursions present the object in its natural colours. It is the best way to study geographical facts as they exist. These excursions serve a very useful purpose in the formation of character of a pupil so that he may not be a misfit in the society. A wise teacher can arrange a good number of opportunities of paying visits, at least, to local places if not to distant areas. When pupils are taken out they may be encouraged to observe carefully the physical phenomena and the social, economic and industrial conditions. The easiest and the most important thing to observe is the natural objects like the landscape, land formations and different types of soils. A journey of hilly area, to a river or of the sea-side may explain terms such as erosion, deposition, shells, grade and v shaped valleys, etc. Similarly, a visit to a zoo may explain the habitation of plants and animals and the natural conditions required for them. Thus a teacher can come across varied material for the teaching of physical geography. Local journeys are as useful as travelling in distant lands, because a neighbouring town is as good an area as any part of country. Other places of interest for visits are the industrial and rural centres, factories, railway-yards and railway stations. The visit to these places will greatly help in the study of regional and economic geography. Similarly, mines and mills like coal, iron and manganese mines and the textile mill, oil mill and sugar mills are as educative as the agricultural fields in the rural areas.

The out-door observation work should be very closely correlated with in-door work. The results of these visits may be expressed in the form of maps or geographical essays or stories and, if possible, in the form of relief models. Such visits or journeys not only enable the child to verify fact read in books but also add reality to them and enable students to learn things first hand. The teacher should see that the trip party is fully equipped and that it consists of a photographer, a musician, a singer and an incessant talker. The aim is that learning and laughter should go together. The excursion method of teaching geography fosters such social virtues like co-operation, give-and-take and group feeling. Whatever excursions are carried out the success of an excursion demands careful planning and organisation. It would bring creditable success if the teacher has been to the locality before it is visited by students and also if the pupils are provided with maps of these areas. A substitute of the actual journey is to have a talk with travellers of other lands like the Japanese, the English and the Americans, who may be induced by means of questions to relate their experiences. Another alternative method is to read books on trável. It will be useful to mention the utility of such magazines as of the railways, steam, navigation and air companies.

3. *The Laboratory method*: In this method pupils are active participants in the act of learning. They are not merely listeners to the lesson but are compelled to observe carefully or to perform the experiments with their own hands. They are supposed to describe each step of performance and to draw inferences from what they have observed or performed. In this method the pupil has to make use of his hands or eyes or both. The object is to make the hand and the eye useful servants of the brain.

The word laboratory implies three things :

(1) learning by doing,
(2) learning by observation and
(3) learning by investigation.

The laboratory method in a broad sense means the individual work done by a pupil as in the case of Dalton plan or the Montessori method. The word laboratory is associated with the statement that the onus of learning falls on the individual. Physical geography and map-work lend themselves mostly to this method of treatment because the teacher and the pupil can both perform, as in a science subject, certain experiments based on scientific principles to make the topics more clear and illustrative. By performing such experiments the teacher tries to demonstrate the underlying causes. Just to give an idea, the following experiments may be quoted as examples :

(a) To explain the cause of winds a lit flame may be placed at different places.
(b) Formation of clouds may be explained from the evaporation of water partially from clothes and by a tumbler containing pieces of ice.
(c) A magnetic needle may be used to show the directions of North and South.
(d) Rotation and revolution may be explained by rotating a ball round a lamp.

A word of caution is necessary here. When some body is performing an experiment it is most desirable that apparatus used should be tested before hand and all experiments be rehearsed, preferably, under the same conditions, as those under which they will have to be shown. A calmness of attitude should be cultivated. Experiments should be striking, clear and convincing. Another example of teaching geography by laboratory method may consist of making models and maps of the various items studied, e.g. human settlements, races, animals, trades of countries and occupations of the people. Children may be encouraged to write accounts of geographical journeys and excursions. This method is an excellent means of arousing interest.

4. *The Project Method*: A project is "a problematic act carried to completion in its natural setting". The project method is the expression of the revolt against the bookish method in which students

were spoon-fed with facts and information. A project is akin to real life and when scientifically carried out, demands initiative, self-reliance, skill and patience. It is because obstacles presented by the method are those which may occur in one's real life.

Psychologically it is based on the principle of learning by doing. The child derives satisfaction when he has achieved something. The project method encourages maximum amount of purposeful activity on the part of pupils. The second notable point about this method is that it employs sense and not mere words or symbols. Muscular activity is the essence of this method. It is also necessary that the materials used by pupils should be within their comprehension and means and that the project may lend itself to be completed within the given time. In this method every pupil shares the lesson in different phases and the method ensures sustained efforts on the part of pupils. The subject has a bearing on real life and there is no cramming at all. Lastly, it fosters social qualities such as co-operation and the spirit of give-and-take. Projects may be individual or co-operative, large or small and they may be employed according to the mental age of the pupils. Following are some of the geographical projects which can be conveniently employed in schools.

Geographical projects may consist of running of a vegetable stall or cloth shop ; cultivation or ploughing of a field ; running of a house, a school, an agricultural farm, a post office, a railway station a grocer's shop, and a stationery shop. Village and town markets are other geographical projects. Similarly pupils may prepare a weather record based on the climatic reading of the local area. Another type of project consists in the preparation of models of house, school, local region, means of transport of one's province, railway station, crop fields, hill stations, etc. For senior students the following projects are recommended :—

(1) Making sand or clay models of different sections of the various river valleys, the Ganges, the Indus, the Narbada of the Irrawadi.

(2) Life in the various parts of the world—Tundra region, Desert region, Equatorial region or Grasslands. Pupils may be encouraged to stage a play showing the life in various regions of the world.

(3) A hill scene, e.g. Simla, or Nainital, showing a railway line, a bridge, cultivated fields ; roads and other important features; the human life, a post office or a church.

(4) Pupils may be asked to prepare economic and distributional maps of the local area. In this case the teacher must be prepared to offer as much help as possible, particularly, in the collection of data from various sources.

(5) Setting and running of geographical museum is another important and useful project of educational value. Pupils should know how to run a museum.

(6) Pupils may be encouraged to read papers and organise excursions. Thus, the collecting instinct which is not uncommon among children can be made use of.

(7) Pupils may cultivate a vegetable or a fruit garden. They may cultivate the land and fence the fields or organise the sale and purchase of fruits and seeds.

Sometimes efforts are wasted in an attempt to base the whole of geographical syllabus on projects. This is not very practicable. One or two projects per class per month will do. Let these projects be spontaneous and neither too ambitious nor too advanced. The project method trains the pupils in the exercise of invention and self-responsibility. The child gets training in research work also. It also cultivates necessary social qualities. The greatest drawback of this method is that it is rather scrappy and consequently gaps are left. Besides, there is no provision for drill work.

5. *The Regional method.* This is another method of teaching geography. It was Herbertson who gave impetus to this method by dividing the whole world into broad climatic regions. Now-a-days the natural region method has become the most common and universal method in teaching the regional geography either of the world or individual country or a continent. Herbertson based his classification on climate and vegetation. This naturally means that nearly all geographical factors are taken into account. Geographers are of the opinion that Herbertson's classification of the world can be used in a modified form. His classification is of great value in sub-dividing the continents and in analysing the factors which influence human activities. Those countries which lie within these climatic divisions may further be divided into structural zones. In the study of a particular region there is a considerable scope for a varied method to be employed. Some teachers work back from human efforts as resultant from the physical causes, while the usual plan is to make a start from physical geography. The following is the most common procedure.

Location, structure, relief, drainage system and climate are first taken in a serial order and then, pupils are led through the biogeography of the region i.e. natural vegetation and animal life in relation to its human geography, which includes the study of agricultutal and pastoral occupation. After this, distribution of minerals and their exploitation in the development of industries are dealt with. This is followed by a study of population and its distribution, means of communication and the location of towns. Finally, the region is studied in relation to other regions of the world. The various natural regions of the world as suggested by Herbertson suffer from some drawbacks. The following order of natural regions may be followed:—

(1) Arctic regions and hot regions.

(2) Tropical forests and monsoon lands.

(3) Temperate grass lands.

(4) Regions of Mediterranean climate.

(5) Temperate forests

It is desirable to begin with the region exhibiting the simplest and the most self-contained human life and proceed through the intermediate types of those that exhibit the greatest economic and political development. In dealing with each region, the advance of human civilization on earth must be stressed. The arctic regions present the most primitive type of nomadic hunter while the desert lands are more advanced both economically and socially. Similarly, the temperate grasslands will show a primitive type of nomadic pastoral people. The American plains show the influence of settled conditions of mankind. The temperate regions present a greatly advanced society.

By regional method we mean two things. In the first place, the whole world is studied by dividing it into natural regions. Secondly, each continent or country or district is studied under certain heads e.g.

(a) structure
(b) relief
(c) climate
(d) vegetation
(e) minerals and
(f) life of man.

Thus, one may study the geography of Delhi or the Punjab or India or Asia or that of the world under these heads. To sum up, if the world as a whole is to be studied it is done through the natural regions and if any part of the world is to be studied one should follow these heads. It is recommended that when pupils have studied regional geography of two or three countries e.g. Asia, India or Africa the students may be asked to study the geography of China or Japan or Ceylon independently with the help of a good atlas. In this study pupils may be required to prepare maps showing distribution of population, minerals and climate. This study may also require them to prepare distributional maps and statistical diagrams. The regional method lends itself to independent study and it can be resorted to individual methods of teaching. The method is orderly and systematic. Further, the work done on one continent trains the pupil in the general method by which problems of the other regions may be tackled. Above all it demands a study of human development on the earth and its extent in the world which is the essence of modern geography. The greatest demerit of this method is that there is too much digression and repetition as the student is supposed to follow the same plan again and again. Thus there is no advance in the outlook and insight. The scene changes but the method of approach remains the same.

8

Regional Studies Through Time

Concept of Region

During the last two generations, the study of foreign lands has been loosely classified as regional geography. Thus areas are described as regions regardless of whether they conform to the definition of a region. Geographers have framed several definitions of a region so as to be of their comfort on every occasion. It is resolved that the region is simply an idea or a method to help in the study of the world. Hartshorne concludes that the aim of geography is to study the inter-relations of phenomenon on the earth's surface, their real differentiation and to give world comprehension. To gain world comprehension, the geographer needs to divide the world from the very start to make the task easier. The earth's surface is the only one region for the man to live on. In order to study the diversified environments of this region, the geographer searched for some ready-made units or regions to serve as manageable portions. The idea of region is so personal that Odum and Moore collected forty definitions yet they failed to formulate any satisfactory definition of a region. In most cases, the regions are regions of relief and the other phenomenon like rainfall, temperature, soils, produce and population are considered subsidiary. Geiger has shown that a slight difference in the texture of the ground will affect the temperature, evaporation, soils, vegetation and crops. This system of division based on relief has been in use since the 18th century when Buache found the earth's surface as consisting of river basins bounded by mountain ranges. His basic idea persists today with many modifications. One development is to take drainage basin as the essential unit and the other is to treat some mountain ranges as regions themselves and not to regard them as boundaries. So the major features of relief have formed the basis for regional division and this has proved so convenient that there is a tendency to play down its drawback.

Nature is the main theme in geography. From ancient Greece until the 20th century many geographers have written a lot on the elements of physical geography like land, climate, the flora and the fauna, etc. During the 19th century it was felt that Physiography was having the human side as well and this developed the idea of 'determinism' which focussed attention on the significance of the physical environments on Man and his action. Partly influenced by determinism, Herbertson divided the whole earth into climatic regions so as to distinguish the different climates and types of natural vegetation existing on the earth's surface. Unstead, on the other hand, started from the selected centre and stretched out as far as its boundaries shared the characteristics with the centre. Paul Vital de La Blache based his division on the distribution of population.

The Compage

Kimble is the greatest critic of the regional concept and condemned it as completely useless. He qualifies that collecting and analysing data about a region is a herculean task for one man and suggests that the work should be split up among several people. Hagget's method of 'locational analysis' for mapping phenomena by indirect observation was considered useful but cumbersome. Since 1951 most discussions about the region have referred to his criticism of the regional concept. Hartshorne, on the other hand, has considered geography as a cross section of a wide variety of disciplines and argued that the subject matter of geography lends to and borrows interest both from sciences and humanities like the bee sucking honey from every flower.

As an alternative to the regional method Roger Minshull has advocated the idea of 'Compage' as put forward by Derwent Whittlesey, who defined it, "as an uninterrupted area possessing some kind of homogeneity in its core, but lacking its defined limits, an area throughout which accordant areal relationships between the phenomena exist. Whittlesey followed Hettner's method of choosing regions with varying topics, but he wanted to avoid a rigid number of topics. Minshull on the other hand, has prepared a list of twenty topics but open to other possibilities. The inclusion or exclusion of a topic will much depend on the contents of the core and on the interest of the individual geographer. Minshull has further suggested to make certain topics the foundation for everything else with emphasis on human geography. Dryer similarly pointed out that just as vegetation can bind together climate, soil, and relief, so the economy can bind together human actions with the physical environments and has advocated that the climate being the resultant of relief and structure may be made the central topic in the consideration of physical geography. In short, Minshull concludes that the word Compage is used to represent one particular aspect of regional geography, to one particular type of region and to one particular method of working.

The Systematic Geography

The regional method has been universally adopted so far because of its achievements but it seems incapable of any further development because of its inherent shortcomings. In consequence of growing criticism of the regional geography method, systematic geography is becoming a more respected branch of the subject. The two branches are, in fact, complementary and possess distinctive qualities. The regional geography is qualitative, complex, academic and subjective, whereas the systematic geography is ·technical, logical, exhaustive and easy to comprehend. The systematic geography proceeds with one topic throughout the world quite separate from other topics in one place. The ancient giants like, Varenius, Humboldt and Ritter have endeavoured to recognise the regional and systematic geography as the two separate approaches to the subject but some overlapping has taken place unnoticed. The systematic geography may arrange its material on a regional basis, that is, by continents and countries, provided it is limited to one topic to be considered throughout the world. If a correlation is brought about between physical features and those of human geography, it will make the subject humanistic rather than an empirical science.

One of the problems of the contemporary geographers is that of developing, disciplining and organising the subject so that it retains both appeal and respect. The old term, 'regional geography' inexplicit in itself may be unsatisfactory, yet the geography of other lands remains a necessary part of the general knowledge. So the phrase, 'area study' or 'compage' has been adopted. The term covers geographical work pursued in a well-defined area of the world.

The compage method is also by no means perfect though Roger Minhull considers it to be the best so far devised. Hartshorne had offered something similar to the compage even long before Whittlesey but he was not satisfied and wanted some one to improve upon. He was not happy to divide the world by a synthesis of topics because it would not result in useful concepts. He went to the length of discarding the well-known systems devised by Ritter and Hettner—Groups of specific regions ; by Herbertson—Natural (physical) regions ; by Stamp, Van Valkenberg and Unstead—similar to those of Herbertson and by James and Passarge—Geographic regions based on vegetation. Herbertson's system of climatic regions is misleading in so far as it makes us believe that natural regions do exist ; that natural vegetation is the result of climate, soil and relief ; and that Man submits completely to his physical environments. Admittedly, this is not true over much of the earth's surface. Roger Minshull finally concludes "that there is no one definition, no one method of recognising, delimiting or describing the region. Just as the world is unique, justs as each continent or country is unique, so each· region is unique and requires a unique approach."*

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* This chapter is an extract from the paper "Regional Studies through the Time". A problem in "Geographical Methodology" presented by the author in person at the International Geographical Congress held at Montreal in August, 1972.

9

Aids to Teaching Geography

The existing system of 'teaching geography in Indian school calls for a thouough overhauling as it is hardly carried out in the true scientific spirit. There had been a steady improvement in recent years, yet much has to be done to make the subject lively and interesting. Recently a survey was carried out to determine the status of geography among other school subjects in the school curriculum and to examine the aptitude of the students towards the subject. It was found that the students generally appreciated the contents of the subject but did not always appreciate the method of teaching. Further, they appreciated the geography lessons when the teacher had created interest by employing attractive teaching materials as the students then considered geography lessons relatively much easier to learn. The need for improving the teaching standard in geography deserves special consideration to remove the existing shortcomings.

It is deplorable to note that there is a lack ot understanding among the teachers as to the contents and requirements of teaching geography. It is also noted that very few of the schools have on their staff teachers trained in geography with the result that some of the secondary schools have been obliged to entrust the teaching of geography to teachers with a poor knowledge of the subject. The lack of interest of teachers of geography in this direction has led to the neglect of the subject in the class room. It is also noted that geography sections of schools need strengthening in terms of equipment and qualified teaching staff if the schools have to function properly in the subject. The task for teachers of geography is twofold ; to assemble the media by which decisions concerning ranking order of different learnings can be made and to select and organise study materials and experiences in geography that lead to the proper understanding of the subject. This can help geographical studies in schools to adjust suitably to new demands and new knowledge. Though some of the geography teachers are well-qualified, they are not well-trained in the art of teaching. Besides, the work-load and dearth of equipment and other facilities stand in the way of school teachers engaged in the teaching of the subject. The managing bodies of the schools have displayed lack of interest about geography by allotting insufficient funds to the geography teachers for equipping the geography museum and geography room with maps, books, illustrations, photographs, diagrams, charts, mineral collection and many other teaching aids.

The problem concerning the teacher, the pupils and school management may be discussed at geography faculty meetings to devise ways and means of putting into practice the modern methods of teaching available through recent researches. Group seminars may be arranged for the benefit of school students for discussion to various topics of geography. In addition the geographical talents of the country may be invited for frank and free discussions on the subject. There should also be gathering of geographers and scientists of allied disciplines for an exchange of ideas on topics of mutual interest. This will certainly help the cause of geography and perhaps to a certain extent, may pave the way for developing geography as an inter-disciplinary subject. No academic subject can prosper without having strong societies and associations to nestle it. There are a few geographical societies at regional levels in our country each of them catering to the needs of the subject at the university level, but it is unfortunate that none of them finds favour with the development and methods of teaching geography in schools.

The poor text books, ill-defined syllabi, slipshod method of cramming and the present day faulty system of examinations in India are responsible for confused teaching of the subject in the schools, which mainly consists of slipshod method of cramming. In a developing country like India, syllabi and examination system need to be revised and school text books have to be changed to bring them in line with the modern needs of a new emerging nation. It is strongly urged that geography text books should be written from an Indian point of view and it demands immediate attention of the advocates of geography and professional geographers. The problem of testing geographical knowledge in schools is yet to be solved. The tests should be framed with a view to creating necessary enthusiasm. The consensus is that in evaluating the answer papers in geography, higher credit should be given to answers based on sound reasoning. It is recommended that unit tests, diagnostic tests and performance tests should be encouraged among the students as far as possible through writing of original stories and essays. The students should be encouraged to give brief answers to objective questions.

Geographical aids are the means of modernisation of methods of teaching Geography in schools. These devices make learning of geography interesting and attractive and their absence makes the lessons dry and ineffective. In the same manner practical work has important role to play in developing geographical knowleged of the students. Field work in geography imparts first hand geographical understanding and makes the subject easy to understand. Field study and pictorial illustrations are of course an essential part of a geography lesson, the latter being most effectively used when examined before and after lessons on a particular topic. For actual class teaching, however, it is generally agreed that black board diagrams built up stage by stage as the lesson proceeds, are the most effective means of exposition. Pictures have proved a valuable and attractive feature of the lesson as they provide materials for discussion. In the case of photo interpretation technique, the scale is an important factor. It is commonly agreed that the most suitable scale is of 1 : 20,000. Optical instruments for magnifying objects should be used with any scale since with their help even the minutest details can be focussed with the human eye which may escape the naked eye due to lack of necessary power of resolution. Models are also important for evaluating, appreciating and interpreting realistic life situations. These provide a system within which new learning and facts can be easily identified.

The development of geography from a descriptive science to a branch of research which investigates the functions and structure of certain parts of the earth is reflected in the modern thematic cartography, with the help of which a series of new school maps, and atlases have been prepared. These are bound to produce the most desired effects. It is essential that the education in secondary schools should involve the use of map as a source of geographical information. The method of teaching applied geography in schools should lay emphasis on the wider use of maps. The importance of co-ordinating some of the maps in the school atlas with wall maps and other types of maps need hardly be stressed. The teacher should take an ordinary map, simplify it and convey the main features to be mentally photographed by pupils so as to be reproduced by them as a sketch map. The sketch maps should be so drawn as to illustrate the salient features of the subject matter of the topic under consideration. It is desirable that each pupil should be able to understand, memorise and reproduce a map of the subject matter taught. At least one third of the each lesson should be devoted to the study of the maps or diagrams. In the same manner, sample outline maps in plastic for desk use, maps which can be drawn and washed off clean for further use are other useful materials. The traditional physical maps can now be better adopted to the picture of the world as seen from the air. Layer tints can be devised in such a way as to reduce to the minimum the sharp contrast from one colour to the other. Symbols for towns should be bold and natural against the traditional circle and dots. Natural vegetation may be shown in different lighter colours. Relief forms can be exhibited by oblique shading. Distributional maps, survey maps, statistical diagrams and models can also be conveniently employed, e.g, a wheel diagram or a bar diagram may be prepared to illustrate the trade or production of a country or countries, graphs may be used to show the variations in temperature, pressure or rainfall. Then again, classroom sketches prepared by the teacher can serve a good ground for observational work. It should be noted that the best diagrams are those which are prepared in the class and in the presence of the pupils.

The map aids for visually handicapped students are in acute shortage because thay have to meet special requirements with regard to linear scale, size, the initial point of orientation on map, simplicity, brailing and training in map reading. The psyco-physical survey undertaken has disclosed that visually handicapped pupils can discriminate symbols on maps more effectively and at a greater viewing distance if the symbols are in white against dark background. These findings may prove useful in preparing special type of map aids for students with defective vision in schools. For this purpose more emphasis should be laid on design and production of large scale maps in which form of symbols should be bold and clear and well-designed. The amount of information to be shown on the map should be limited so as to make it legible and easy to be reproduced and at a reasonable cost.

Globe : A globe is indispensable, because it always conveys the impression that the earth is round. A globe may be as large as 19″ in diameter for the class use and as small as 4″ for personal use. The slate globe may or may not have the outlines of continents drawn on them and it is very useful in earlier stages for showing directions, days and nights and motions of the earth, etc.

Text-book : A text-book is a tool both in the hands of the teacher and the taught. A text-book gives continuity and cohesion to the teaching process. A well-chosen text-book forms useful basis in the new lesson and affords material for hometask. Even pictures contained in a text-book permit putting questions on them. It should be clearly understood that a text-book gets out of date, and the teacher has to take special pains to keep his knowledge up-to-date and select only modern text and reference books.

A text-book is the most commonly used of all the teaching aids. In fact text-books and note-books are some of many aids available to a teacher. But there is too much dependence upon the text-book. The concept of the text-book has changed today as it is considered to be a course of study rather than as a source of information. A teacher should not depend upon a text in its entirety. Some of the teachers are in the habit of following reading recitation technique by which the pupils are made to read sections of the text-book and repeat them parrot-like. If such a technique is employed indiscriminately it will weaken interest of students. This technique can be usefully employed where some exceptionally important point is to be stressed. The illustrations, pictures and diagrams in the text-book should be utilised for discussion and application of knowledge. In fact a text-book should be used for reference because it helps to gain an over-all view of the topic. Almost every teacher has to select a text-book at one time or the other. His decision will be important because the text-book so chosen will shape his plan of teaching the subject in the class. In selecting a text-book the teacher should give consideration to the reading capacity of his pupils. Some pupils read with difficulty and do not like to go through the books. In the same manner retarded students will need help of the teachers in the form of notes. The teacher should apply objective tests like the following, in evaluating a text-book for his class.

1. The contents should be accurate and adequate for the age level and should meet the needs and interests of the pupils and should conform with the state syllabi.

2. The concept should not be difficult or ambiguous.

3. The literary style should encourage pupils to read the text-books and the vocabulary should be well-chosen.

4. Photographs should be well-reproduced and should amplify the contents of the chapter.

5. The quantity and quality of illustrations should be reasonably good.

6. The exercises at the end of a chapter should meet the demands of the teacher and should be closely related to the contents of the chapter.

7. The general get up, appearance, binding, size of the book, quality of paper, the type and length of lines are other factors worth consideration..

Tests : The device of tests should form a part of teaching process. Tests can be used at the beginning, at the end as well as in between the year. Tests should never be used as a measure of success but occasionally, these may be given for determining the grades. There are many types of tests, one for almost every purpose e. g.

(1) test of vocabulary ;

(2) test of understanding ;

(3) test of motivation ;

(4) test for review and drill ;

(5) test for achievement.

Similarly test items can be grouped into three categories, purely verbal tests, tests which involve pictures and diagrams and tests that make use of actual material. Each type has its own values and limitations.

The function and nature of the test, degree of skill and learning acquired by the pupils and the way the test is to be conducted are some of the factors to be considered before constructing a test. It is desirable that prospective pupil teachers should be very cautious about using tests as a device of teaching test these should kill the interest of the pupils. It would be improper on the part of the teacher to demand mastery of the topic by the pupils when that topic was treated casually in the class room. This would cause injustice to the pupils and they may develop hatred both for the teacher and for the subject. Variety and ample choice are important considerations because these factors reduce fatigue and give pleasure to the pupils. Variety provides opportunity to the pupils to display their knowledge, understanding and talent. The questions in the test should be direct and simple; the words used should be those which have been commonly used in the class room.

Field Work : A class room has a limited space. The limited equipment of the class room have no comparison to the bountiful resources of nature outside the class room. Nature can serve as a laboratory where the teacher and the pupil can carry out unrestricted experiments upto any length of time. Field experiences are, therefore ,useful as they permit first hand study of actual objects and geographical situations. Field work awakens interest which the class room teaching cannot do so. Thus plants and animals can best be studied in the fields because their natural habitation is marred by artificial surroundings of the class room. Similarly there are certain other geographical situation which cannot be studied in the class room because of size, inaccessibility and inconvenience. The geographical situations like contour maps, weather reading, waterfall and erosion, can be best demonstrated outdoor rather than in the class room. Experiences gained outdoors are basic whereas those acquired in the class room teaching are only supplementary. During field work, all senses are actively functioning and the observation power is much emphasized because of direct contact with things. These first hand experiences are accurate and lasting. Field trips for younger pupils can be arranged within the vicinity of the school because long trips require use of transport and money and involve many administrative problems. Besides, long trips require advance preparation and are time-consuming and may require permission from parents and school authorities. Occasionally, long trips may be arranged by senior students as they will be capable of planning trips better. It is, however, recommended that the teacher should always anticipate the accompanying problem of transport catering, boarding and lodging and should make all arrangements before the journey is actually undertaken. There will be then no scope for disappointment.

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Aids to Teaching Geography Maps

Maps : These are essential tools of the teacher. By these means the teacher can focus the attention of the whole class and can illustrate better than by oral description. Pupils may be asked to observe the water courses and land forms or the topography of a region. Although maps are limited in scope, yet they are of immense use in the teaching and learning of geography. Similarly, outline maps or plans may be used to explain scales, directions and positions.

Maps and their kinds : The importance of a wall map in a geography lesson is quite evident. It was strongly recommended by a noted educationist, Sir Hadford Mackenzie, that a map is the tool of the geographer and, therefore, no lesson in geography can be called complete without the use of a map. A map summarizes the main points of the lesson and saves labour and time even in the examination. A geography teacher realizes that his lessons without a map are meaningless. Besides, more can be expressed in a single map than by volumes of speech or writing. Lastly, wall maps are important because attention of the whole class can be easily focussed. There are various categories of maps and they are used according to the mental state of the pupils.

(a) *Picture maps*—Young pupils can appreciate picture maps better. Therefore, in these maps the outline of a continent is drawn and the important features are represented by pictures, e.g. mountain ranges by brown lines, desert scenery by a picture of a camel in a yellow background. Even a simple picture does convey some geographical idea.

(b) *Physical maps*—At the next stage brightly coloured physical maps are introduced. In these, low lands are shown by green colour, uplands by yellow and mountains by brown. In order that the pupils may understand the meaning of the map, the following steps should be followed :—

(i) Start may be made from the photographs of a well-known landmark.

(ii) Aerial photo of the same object may be introduced.

(iii) Vertical photo of the same object may be shown.

(iv) Map of the area may be presented.

(c) *Survey sheets*—These are drawn on a scale of 1" to a mile and are published by the Survey of India. Exercises based on direction and scale, etc. may be set on them. These maps are available with the office of the Deputy Director, Map Publication, Maps Record and Issue Office, Survey of India, Calcutta.

(d) *Bathy-orographical maps*—These show heights and depths by means of symbols and colours. There is a very large variety of these maps and one of the following series may be purchased for school purposes :

(i) W.A.K. Johnston's Bathy-orographical series of wall maps (of each continent). It can be had from Macmillan & Co.

(ii) Philip's comparative wall atlas (world relation). Its agents are Orient Longmans Ltd.

(iii) Complete set of Philip's comparative wall atlas. Each set contains eight maps mounted on linen to enable folding and arranged in a manner—Physical, Political, Temperature, Rainfall (summer), Rainfall (winter), Natural vegetation, Density of population and Commercial development.

(e) *Blackboard maps*—In order to save the trouble of drawing maps on the blackboard, these are a good substitute. The following series are available :

(i) Outline maps of the States of India.

(ii) Continents of the world.

(iii) Countries of Europe.

(f) *Atlas maps*—An atlas is a great necessity for every school child. There are a number of atlases available and any one of them may by recommended :

(i) Bartholomew's Indian School Atlas.

(ii) Messrs George Gill & Sons' Junior School Atlas.

(iii) The Oxford Advanced Atlas.

(iv) Philip's Senior School Atlas.

(v) Lyde's Atlas of Economic Geography.

(vi) School Atlas—Survey of India.

It must be remembered that a map is a useful instrument of learning and teaching. Therefore bulk of the geography work should be done with reference to atlas maps. An atlas provides the skeleton of the geography lessons and geography teacher clothes it with the flesh of subject-matter.

(g) *Memory maps*—There are other types of maps which are drawn by individual students and these are known as Memory maps.

Their importance lies in that they afford a chance to students to give expression to their factual knowledge.

The Survey of India and the National Atlas Organisation, both under the Ministry of Scientific Research and Cultural Affairs, Government of India are actively engaged in carrying out cartographical research in India. The Survey of India is devoted to geodetic and topographical surveys and preparing up-to-date maps covering the whole country. The National Atlas Organisation is responsible for preparing various thematic maps for country's planning. In addition to these two primary institutions there are other departments which prepare maps for specific purposes. The Geological Survey Department has published specialised geological map of India on the scale of one inch to 32 miles (1 : 2 M. approx.) in 1932 which is being revised. Similarly, large scale geological mapping on a scale of one inch to one mile was done during the period 1956-61 and again during the Second Five-Year Plan period. The Meteorological Department of the Government of India is entrusted with the preparation of climatic maps of India on the pattern of the world Meteorological Organisation. Recently the Registrar General and State Census superintendents have undertaken to prepare census maps—based on All India Census in 1961. The Ministry of Power and Irrigation has prepared map of the Damodar Valley based on the Diagnostic Survey. The Calcutta Metropolitan Planning Organisation has undertaken to bring about maps based on aerial photographs. The Land Utilisation Board of West Bengal has brought about a land use map of West Bengal on the scale of 1 : 500000. The National Council of Applied Economic Research has published nearly 500 small scale maps for the Techno-Economic Surveys of the different states of India. The Indian Statistical Institute has also prepared quite a number of maps for planning. The Indian Agricultural Research Institute has published the soil map showing distribution of 20 soil types in India.

Maps may be classified according to (1) the scale of the maps they show and (2) the subject or theme they show and are called Thematic Maps.

1. *Scale Maps*: Maps according to the scale are the following :

(a) *Cadastal Maps*: These are drawn on a very large scale upto 25 or more inches to a mile.

(b) *Topographical maps*: These are also drawn on a large scale. The scale ranges from 1" to a mile or four or more inches to a mile. The survey maps fall under this category.

(c) *Chorographical maps*: These are small scale maps of the various parts of the world showing typical features by conventional signs. The atlas maps fall in this category.

(d) *World Maps*: These are also small scale maps showing the whole world.

2. *Thematic maps* : These maps are classified according to some important features which they show. The main types are :

(a) An outline map shows only the boundaries of the countries and continents.

(b) A political map shows the political boundaries, states, districts, towns, roads and railways, etc.

(c) A relief or physical or orographical map represents the nature of the land surface by means of contours and colour tints.

(d) A bathymeteric map shows the depths of the oceans with tints of blue colour.

(e) A bathy orographical map is a combined map showing depths of oceans and heights of land surface

(f) An ethnographical map locates the distribution of the races of mankind.

(g) A vegetation map is one showing the distribution of natural vegetation.

(h) A biological map shows the distribution of flora and fauna.

(i) A whether map is a map showing the distribution of temperature, pressure and rainfall for a short period only.

(j) A climatic map shows either the distribution of temperature, or rainfall or pressure or winds of a combination of all these for a particular season as for example, a map of India showing winter or summer temperature.

(k) A distributional map shows the distribution of some commodity or stock or crops.

(l) A commercial or economic map shows the area of production, distribution of exports and imports, density of population, railways and other routes.

(m) A geological map shows the distribution of rocks. Geology is the science which studies rocks.

(n) A topographical map or ordnance survey map is a large scale map showing the details of topographical features and drainage.

(o) The international map is an ordnance survey map drawn on a scale 1 : 1000,000. It is divided into sheets having uniform scales and signs. Each sheet showing some parts can be fitted with other sheets to show the country as a whole. It is drawn with the co-operation of the various countries of the world.

Atlases—National, Regional and Topical

In 1909 the first comprehensive atlas of India was published as a part of the Imperial Gazetteer, and it was revised in 1931. A period of great activity in the field of specialised atlases commenced in March 1949 with the publication of S.P. Chatterjee's "Bengal in

Maps". Thereafter a statistical Atlas of Madras province was published in 1949 by the State Government. In 1953, another atlas called "Bihar in Maps" by P. Dayal was published. In 1950 *India in Maps* was published by the Government of India containing maps on the scale of 1 : 15 M. The next period of activity was witnessed by the publication of the first National Atlas of India (Hindi Edition) in 1957. This was followed by a more comprehensive National Atlas. The Power Atlas of India published in 1956 shows electric power development and distribution in India. The School Atlas was published in 1961 by the Survey of India which comprises maps of the world, continents, neighbouring countries of India, States of India as well as physical and economic maps of India. During the last five years a number of atlases have been published. The National Atlas Organisation has prepared eleven plates of Transport and Tourism maps on scale of 1 : 1 M, in addition to physical maps of India on scale of 1 : 6 M. The Registrar General, Census of India, has published Census atlases of states of Madras, Orissa, Punjab, Uttar-Pradesh and Rajasthan. The Indian Council of Medical Research has published in 1964 a Diet Atlas of India on the basis of data supplied by the National Sample Survey of the Government of India. The Directorate of Land Records of Madhya Pradesh Government has also prepared an atlas on agro-economic conditions of the state.

In this connection it may be pointed out that no sooner the maps are published they become out of date because after partition of India the Indian toponymy is changing from time to time. New townships and new districts are coming into existence and the states of Rajasthan, Assam, Madhya Pradesh, Kerala, Punjab and Maharashtra have undergone administrative reorganisations and new States like Manipur, Meghalaya, Nagaland have also come into existence. The Government of India have therefore set up an Advisory Board for National Atlas and Geographical names.

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Aids to Teaching Geography :Audio Visual Aids

Audio Visual Aids are the devices employed to provide substitutes for first hand experiences. These aids, which make use of the senses of vision and hearing are comprised of :

(1) Educational Films,
(2) Filmtrips and Slides,
(3) Pictures,
(4) Charts,
(5) Models,
(6) Records and Tape recordings,
(7) Radio and Television,
(8) Demonstration, and
(9) Maps.

The audio visual aids are making their own contributions to educational methodology. Photographs and films are the only visual measures for presenting information about inaccessible places and prohibited situations. Similarly, after a visit to an industry, factory or to any geographical situation a film can present a summary of things seen in the field trip. Photographs can thus give understanding about inaccessible geographical situations in far off situated lands and infrequent phenomena. The phenomena of Rainbow or Solar eclipse may not be seen when the teacher wants to teach in the class but a photograph of it can help recalling the past experiences of pupils and studying the unnoticed details. Pictures permit comparison of variations in the geographical situations that might go otherwise unnoticed.

Audio-visual aids have certain limitations. The images produced from audio visual aids are incomplete, distorted, lack reality and do not give any idea as to the size of the object. Sometimes a picture is distorted to emphasize a point. Models suffer from this limitation the most as these are generally distorted making mountains look higher and steeper than they are in reality. The distortion in a geographical model is so conspicuous that pupils get wrong concepts of the size and dimensions of the objects. Models may also give a wrong idea of the material of which it is made of. Pictures may be circulated among the students for study but many of the audio-visual aids require to be projected by various devices like Hand Viewers and Magic lantern, Epidiascope Film projectors of different kinds, Tape recorders and phonographs. It is natural that the teachers should understand the operation of these devices. Despite their limitations audio-visual aids form an integrated part of the learning process. Of course, these aids are not meant to replace but to supplement first hand experiences. Another consideration is as to the type of audio visual aid to be used. Since all these aids have limitations special care should be taken while selecting a particular device for a topic.

1. *Educational Films* : Films are of great educational value to geography students. The still films are perferable for showing some processes—e.g. the manufacture of cotton or the modes of irrigation. Films may be borrowed for school purposes or arrangements may be made with the local cinema to exhibit films to pupils at concession rates. A cheaper substitute of the cinema is a magic lantern or an epidiascope by means of which pictures can be projected on a screen. An epidiascope is better because it can project any picture, while in the ordinary projector or Magic Lantern slides have to be made first. In each case, the teacher should comment on the pictures projected. The educational films can thus supplement the work of a class teacher and are quite useful in helping pupils to gain new experiences. Educational films are valuable in spite of their limitations. These should be freely used to the advantage of the pupils. Films should be catalogued as books. It will be more effective if the teacher can talk over to the pupils on the nature of the films. It is important that the exhibition of a film proceeds smoothly and without any loss of time. No time should be wasted in bringing the image to focus or adjusting the sound or arranging the screen. The whole apparatus should be tested beforehand. After the film show, discussion should be encouraged so that pupils may ask questions on the points which confronted them.

2. *Filmstrips and slides* : Filmstrips and slides are more popular than the films because they are cheaper and economical as compared to films and their projectors are also less costly. These devices enable the teacher to adjust the time to be allotted to any sense for discussion or talk. The projector is so simple to operate that even pupils can handle it. Filmstrips and slides should be arranged sequentially and it is possible to develop a library because of the case with which these can be stored. Slides can be had from many sources. The large slides are usually in black and white and cover photographs and diagrams. The smaller slides are generally in colours and are made from photographs. Slides can be purchased in pieces or in sets. These can also be prepared by hands and such hand made slides are instruments of self-expression for many pupils.

3. *Pictures* : The underlying idea of the use of pictures was realized by Commenius who wrote a book namely, "Orbis Pictus" based on this principle. A picture is a formula of the geography teacher. Besides, a picture always appeals to the imagination of the pupils. Great importance is attached to the use of picture in geography teaching. Pictures help to make many phenomena clear and their study more interesting. A single well-selected picture makes the topic far clearer than a long description. It is not easy to describe a glacier to a person who has never seen it. Pupils may understand the cause and effect of the formation of a glacier but they will not be able to appreciate its size, its appearance, its colouring and its setting from a verbal description, while a picture of a glacier will enable them to do so to a great extent. The teacher should seek the co-operation of the pupils in the collection of the pictures. Even advertisements and cigarette cases may be utilized by younger pupils. These pictures may be mounted on card-board or plywood or tin.

Pictures have a number of advantages in that these are cheap, easy to procure and store. These are good substitutes for inaccessible objects of which the pupils cannot have a first hand experience. The greatest advantage is that a picture often shows objects in its natural surroundings. These are more suited for individual study than for the class use. These pictures may be stored in a folder having a topic heading and the folders are then classified alphabetically.

It is good to keep an index of pictures. Pictures may be handed round the class or projected by an epidiascope or a magic lantern. Pupils may be told what to look for because they require guidance and direction. It may be noted that the description has to supplement the observation of the pupils. A picture, when displayed should be followed by a series of well-arranged questions relating to it. These pictures may be gathered from the following sources :—

(a) Magazine—Pictorial Educational magazine, Geographical magazine, and National geographical magazine.

(b) Official publications—Publications of Government Offices, Meteorological and weather reports.

(c) Newspapers and Periodicals : The Times, The Manchester Guardian, The Daily Telegraph, The Times Educational Supplement, Life, Fortune, and Illustrated Weekly.

(d) Advertising brochures of Shipping, Railway and tourist agencies.

(e) Discarded books and magazines.

(f) Postage stamps.

These pictures may be classified under certain heads like the following :—

A. Towns ; B. Physical Geography ; C. Natural vegetation D. Cultivated vegetation ; E. Minerals and Industries ; F. People and their Modes of life ; G. Animals.

In order to make a successful use of pictures, the following principles may be borne in mind :—

(1) Always maintain an index and a file.

(2) Large pictures may be mounted on a wooden frame of plywood and small pictures may be mounted on butter muslin to avoid wear and tear. Pictures which are to be handled by the pupils frequently get soiled and they should be mounted on cards.

(3) To display small size pictures—make use of some projecting apparatus. It is for the teacher to decide as to what size of pictures are to be used as it depends on the number of pupils in the class.

(4) The teacher should always describe the picture and explain to the students the things to be studied therein.

(5) Each pupil should have a free access to the pictures.

(6) After a picture has been shown, questions should be set on it to sharpen their memory and enrich their imagination.

4. *Charts* : Charts constitute a standard equipment because of their several advantages. However, these should be sparingly used because of their serious limitations. Most charts represent a statistical diagram or a series of diagrams which may be difficult to understand. Charts require less effort for presentation than slides because these may be left up to any length of time although these have greater difficulty of storing. One consideration is that charts should be large enough for general class use. Language should be readable, printing should be distinct, and colour should be effective. A chart should be simple and too many details should be avoided. Charts should be hung on the best-lighted wall. If it is to be hung on a stand, the teacher should check its visibility from different corners of the room. Charts can also be made by pupils without much trouble.

5. *Models* : Models are preferred to pictures and diagrams because they introduce a third dimension though they suffer from the same limitations. Models are of different types. They may be diagrammatic to emphasize a selected feature, or operative to show the motion of the parts. Similarly, scale models are meant to show the appearance of a real object and display models are designated to represent structural characteristic. A model should be large enough to be seen clearly from all sides of the class room, whereas smaller models can be used for individual study. A model should be simple but at the same time it should resemble the real object. The model should be selected according to the age level of the pupils. It is economical to have models made in the class itself because commercial models are usually very expensive. Besides, it will be an advantage to make model to fit a specific situation, because such models may not be available in the market. The making of models can help a completion of project which can give a great satisfaction.

The models are mostly made of clay, plaster of paris, paper mache or laminated paper etc., usually prepared by hand and then painted. This is a cumbersome method. At present the relief models are being prepared by moulding with a metal die. Map details are printed on the plastic sheet, before moulding. This process is costly and time consuming, and at times the result produced are inaccurate. In Japan a new process has been introduced which comprises following steps. In the first instance the exact pattern of each contour is transferred from a map to a sheet of metal by photo and lithographic etching on the metal. These sheets are cut to the shape of the contour patterns and are laminated together in correct position. The original model is thus prepared from which any number of copies can be obtained by moulding a plastic sheet with this original. Clay modelling has several uses in geography particularly for illustrating land forms. Plasticene, which is available in different colours has similar uses and the combination of one or more colours can give a contrast and touch of reality. Plaster of paris is however excellent for permanent models because it is a versatile material and can be subjected to any process. Tools required for these models together with the material should form part of a geography room.

Clay modelling is the cheapest and the easiest form of manual training in handwork and is, therefore, generally the first to be employed in the education of the child. It can very easily illustrate geographical topic. The child can quickly understand such terms as, an island, an isthmus and a cape if concrete models in clay are shown. It is also a good exercise if children prepare models of clay exhibiting some geographical phenomena: Children may prepare models of clay showing the rotation and revolution of the earth, distance of the earth from the sun and phases of the moon. Let one of the clay balls be painted yellow to represent the sun, a white one to represent the moon and a brown on the earth. Pupils may prepare topographical models to show the knowledge they have acquired of a place or of life in any region of the world. For instance, a project may be set on preparing models showing the desert scenery. It will consist in spraying sand in a wooden tray, and making models of a camel, a desert-man made of a clay, a spring and a tent, showing an oasis in the desert

In a similar manner, paper cutting and folding may be associated with some geography lessons. For instance, children may prepare balls by folding and refolding paper of a squared length. If the inside half is painted black and the second half white it will serve as both a good game and a good apparatus to explain the phenomenon of day and night. Another piece of work connected with paper folding can be the repairing of maps by the students. Handwork may also serve geography lessons by supplying apparatus for the geography room and for field work. Wood and metal work may be combined with free hand sketching of maps, and making stencils of different continents and countries. There are many simple instruments to be employed for illustrating geographical topics. These can be conveniently prepared by students in a manual workshop. Some of these apparatus are picture frames, map stands, thermometer stand, pointer and plane table, etc.

6. *Records and Tape Recordings :* Records are not much in use because of their high cost. However, they should be used by schools which can afford to spend. Similarly, a portable tape recorder is a versatile machine and can be employed for broadcasts on geographical topics. Tapes can be easily edited and the portion clipped can be joined with cellulose tape.

7. *Radio and Television* : Radio in recent years has grown into a teaching aid and it should find place in every geography class room. Radio listening contributes to good teaching. Television is gradually replacing radio and T. V. stations have prepared series on different topics particularly in the fields of geography, science and mathematics. Television should be considered as an aid and not as a substitute of a teacher. It is a medium for mass education only and not for individual work.

8. *Demonstration* : Pupils may be made to observe the experiment performed by the teacher and to draw inferences from them. Some of the topics which lend themselves to practical work are the phases of the moon, seasons, days and nights, condensation, currents, and convectional rainfall, etc. Demonstrations are also useful teaching devices as they serve several functions. Demonstrations are generally confused with experiments. In an experiment the result is not known. Demonstrations are usually presented by teachers. Demonstrations arranged by pupils, either acting alone or in small groups, may prove valuable. Demonstrations may be advantageously used in many ways : to set up a problem without previous discussion ; to illustrate a point ; to help solving a problem and reviewing an experiment. A demonstration is economical in regard to time. The teacher in a class can set up demonstration before a class period begins and he can utilise the services of pupils in setting up the apparatus. But demonstrations have limitations and in that much information cannot be grasped by sight and sound because a demonstration has to go fast. A demonstration will be most effective if it is produced in the way a play is produced. Another consideration is that the apparatus for demonstration should be simple but large enough to be clearly visible. It is also desirable to bring variety in demonstration by modifying basic techniques, by means of questions, laughter and exclamation and relaxation because it is difficult for young pupils to sit tight and attentive for a long time. In order to hold attention of the pupils it is necessary to enlist their maximum participation and co-operation.

12

Syllabus in Elementary Schools

The teaching of Geography at the nursery and kindergarten levels should be quite informal and the teacher should simply try to awaken geographical interest in the child. Stories which have a geographical meaning in them may form the basis of study such as the stories of Ramu the farmer, Raju the miner and Koojak the Eskimo. The pupils are introduced to the animal world as the lion, the elephant and the camel. In the clay modelling class they can prepare models of plasticine which can convey geographical ideas. They should be led to have a cursory glance at the nature around them, to give them an idea about the geography of their neighbourhood.

In the primary classes the aim should be to introduce the geography of one's own country to the young child through the medium of things he sees in his everyday life. The text books should tell in very simple language stories of people who live under different conditions in different parts of the world. In addition, descriptive illustrations and photographs of simple models be given so as to acquaint them with the subject of geography through stories. The text books should tell tales about the people and the lands in which they live, like the tales which friends narrate when they return home from distant journeys during which they have seen many new things and people. The stories should also tell something about the topography of the country and how it looks like. These should include topics about the kinds of trees and plants which grow in their countries and why they grow there. Stories may describe the people, their mode of living and occupation and how they move about from one place to another. The children should learn about trade from these stories as to how big ships ply across the seven seas carrying all sorts of useful things which we have in surplus and which other people want, and how these people send us back the things we need. Pupils can also learn about climatic conditions and growth of vegetation from these geographical stories as to why it is sometimes very cool and sometimes cold; why the rain falls and why the wind blows from one place to another. The pupils will know how much rain falls in any place and whether the land is fertile and how some plants flourish in hot and rainy places and fertile soils while in other places these do not. Thus at the end of the primary class the pupils should be fully introduced to the subject matter of geography and should know what geography is through a series of graded text books of geographical stories. It will be of an advantage if the stories are followed by developing questions so that before jumping on to the next topic the previous lesson is thoroughly understood and revised. Some of the illustrative exercises are the following:

1. What is the name of the land in which we are living?
2. Are there any big mountains or rivers near your school, and if so, what are they called?
3. What is the name of your village or town and what other villages or towns are there near it?
4. Draw a picture to show how you would find the points of the compass.
5. Who are the chief people living in your country?
6. What is the language spoken by the majority of the people of the state?
7. What animals help people in the country?
8. What is the chief foodgrain you use?
9. How does your father earn his living?
10. Name the things sold by a shopkeeper in your neighbourhood.
11. Of which material is your house built?
12. Make a model of clay of the house you are staying in, or the one you have visited.
13. Name three types of foodgrains produced in your country and collect samples of each.
14. What kinds of fruits do you like the best? Draw pictures of these fruits
15. Name the different kinds of dresses worn by the local people.
16. Name fifteen things you use which are made in your country.
17. Name ten things which you use and which are made in other countries.
18. What are the chief modes of travelling by land? If you have ever travelled by any of these modes, tell the story of your journey.
19. Make a clay model of a range of hills and a coastal plain.
20. Draw a sketch map of India showing rivers like Ganga, Jamuna, Brahmaputra and their chief tributaries.
21. Draw pictures of a forest and a village.

The syllabus in geography for the primary school is to be designed to give broad guidelines rather than to form a definite syllabus. At this stage certain geographical facts and principles have to be fully grasped but the main objective should be to stimulate pupil's interests in the life of the people and distant lands. It is, therefore, most essential that the teaching should proceed through study and observation. The following are the minimum requirements of geography syllabus of a primary school.

1. An elementary knowledge of the common terms used in geography, like mountains and plains; rivers and lakes and oceans and seas, etc. These terms are to be taught with the aid of sand tray and clay models, pictures, and illustrations from the local regions and homelands.

2. Meaning of a map or plan.

3. Geography of the locality in which the school is situated leading to the geography of the state.

4. Elementary principles of the geography of India in outlines in relation to other countries of the world.

PRINCIPLES OF SELECTION

1. *Aims of Teaching* : The first principle which governs the framing of the syllabus in geography is the aim of teaching the subject. The primary aim of teaching geography is to make the child a true citizen of the world and to enable him to study world problems in a dispassionate manner. In order to broaden his outlook, factual knowledge is the most potent factor. It is generally agreed that bare facts form an indispensable part in any branch of knowledge. Dates, names of places and records of events are the essentials in history. It is on these facts that the subject is based. In order to build a strong house of knowledge of a subject the learner has to memorize facts to form a strong foundation. Therefore, memory work cannot be neglected in the study of any subject, but it should not be the only instrument of studying a subject. What is true of other subjects is equally true of geography. The facts of geography are of a greater importance and more lasting value than those of any other subject. For instance, facts about the composition and preparation of carbon dioxide gas and the causes of the Maratha War have a lesser meaning in the life of a man than facts about China, Russia, Mount Everest, or the Nile or the Ganges, because these are topics of everyday interest. Of all the geographical facts, place names of the area to be studied should be greatly emphasized. It is required that a lower secondary student should have learnt at least 500 geographical features. But in learning facts, discrimination must be used for judging their relevancy. The pronunciation and the spelling of these place names must not be overlooked. If a teacher finds some difficulty in pronunciation, he should not hesitate to seek the help of the language teacher. Thus geography and language will be

correlated and pronunciation and spelling properly drilled. This will create a geographical atmosphere and add reality to the subject. However, all facts are not of equal value. Some are so indispensable that they demand permanent attention. Such facts occupy the same position in geography as formulae in mathematics. The framework of geography consists of such main facts as the distribution of oceans, continents, their relative positions, distribution of mountains, rivers, seas and climatic conditions, main routes and important towns. These facts form the skeleton to which the flesh of geography is attached. There are other facts which are of temporary value only. While we may not take pains to have a permanent grasp of these but the student has to search for facts. Training in the use of-reference books and atlases is also important. The third category of facts have to be forgotten when they have served their purpose.

2. *Mental capacity* : The child in the early stages is very rich in imagination and memory and the instincts of wandering and curiosity are prominent in him. Therefore, the teacher's duty is to develop all these innate faculties by providing suitable material. Facts should not only be learnt but also must be clearly comprehended and understood. As remarked before, facts are best learnt by the sheer force of memory which is very strong in young children but the right understanding of them is possible by studying the relationship of one fact with the other. When facts have been understood they have to be fixed up in mind by reproducing them in the form of maps and diagrams. Since the relationship that exists between one fact and another is universal they are called the general conceptions or ideas or principles. For instance, the relation between temperature and pressure wherein the pressure falls with the rise in temperature and vice versa is a universal principle. The collection of these principles in the mind constitutes intellectual power. Therefore, intellectual power rests on a clear grasp of general relationship. This intellectual power becomes a necessary instrument for learning new things.

3. *Intellectual development* : The child is not much advanced intellectually because his experiences are very limited. Therefore concrete objects have to be introduced. If that is impossible, models and pictures have to take their place.

4. *Map work* : Map is the chief instrument of teaching and learning geography. The aim is to enable the child to read a map, write out a map and think in terms of a map. Therefore introduction to map work must be made at this stage. For instance the idea of a scale and its application and its use must be introduced to the students of the elementary school. Simple plans based on the comprehension of scales may be prepared by the pupils. The hand and eye should serve as useful servants of the brain. Therefore, pupils must be acquainted with the elementary instruments of weather. They should be given practice in talking thermometer and barometer readings. They should also be taught the use of a raingauge.

5. *Physical geography and principles of climate* : Climate is the chief means of dividing the earth into natural regions. The regional method of studying geography is followed in the senior classes. It is, therefore, necessary that principles of climatology and weather are emphasised at this stage. Models, observation of climatic phenomena and use of simple apparatus are useful aids to teaching at the elementary stage. Local geography should form an important part of the course material of the primary school syllabus. It prepares the ground for the senior course because a child is more interested in his own land than that of others. Everything should be taught according to its bearing on human life. The human geography limits the vast scope of geography for school purposes. We must explain the action and interaction of man and nature, as this is the modern concept of geography. In teaching this geography descriptive and narrative methods should be adopted and stress should be laid on the importance of man in conquering nature.

6. *Exigencies of time-table and staff* : Factors like the amount of time available and the number of geography teachers on the staff must be taken into consideration. Geography is a practical subject with its own methods of teaching and therefore sufficient time is needed for its thorough study. The time allotted to this subject in the elementary classes is from 60 to 107 minutes per week. This is quite inadequate and should be increased to 120-200 minutes per week.

7. *Local conditions of climate and environment* : All students are not brought up alike and their social and physical environments differ considerably. These things must be borne in mind. There is no master key which can open the different locks of the geography course. The particular point to be stressed at a particular stage and the particular method to be followed must be noted and made clear. The teacher should always try to adopt the lesson to the needs of the class. Efforts should be directed to group together a number of related facts rather than to present them in isolation.

COURSE MATERIAL FOR THE PRIMARY SCHOOL SYLLABUS

Based on the study of the principles of selection of syllabus, the elementary school course material may be prepared under the following classified heads :—

1. Human Geography.
2. Homeland or local Geography.
3. Weather observation and physical Geography.
4. Map-work.

1. Human Geography

The syllabus should aim at preparing the pupil for healthy citizenship. It should make him realize the interdependence of races and communities. Thus it is a means to an end. It is an instrument of providing material for a broader study of the mankind. The function of geography teaching is more cultural than academic. Everything is to be learnt and taught from the human point of view. It should bring the pupils in direct contact with the life and activities of the human race. It should also bring to the knowledge of pupils the existence of the most backward and the most advanced nations, their efforts to conquer nature and the results and achievements of their struggle, and finally their social, political and economic progress. We study everything from the child's point of view because the child has to spend his life in a world of diverse types of human beings. He has to establish new relationships with other citizens. Consequently, he must develop the spirit of coexistence, 'give and take' and of 'knowing and feeling the actions of others'. Teaching should be so adapted as to meet the needs of a child who has to utilize his leisure in the company of other human beings. The child should gain something so as to ennoble his life by improving his own standard of living and that of his fellow country men. To the intelligent grasp of economic, political and racial problems of the world, geographical knowledge should greatly help. This will help imparting the right vision and thought beçause human geography is one of the foundations of the science of collective living on earth. We should include such portions of human geography which would meet the above demands of the child.

2. Homeland and Local Geography

Under normal conditions only one area can be studied in detail by school children. This is the local area because it is the nearest of all. It forms a basis for the study of the other parts of the world. This home region of the pupil is best learnt by direct method, i.e. by exploration and observation. These instincts are very strong in the child at this stage and therefore should be utilised in full.

After the pupils have observed facts, they should represent them in the form of maps and diagrams and thereby acquire the power of imaginative reproduction through which they will imagine conditions of life in other parts of the world. This group exploration will develop the sense of co-operation and better understanding. In this way a real love for the home district will develop. This is how regional geography is to be taught. In many places local industries, sometimes, give a very good start for a geography lesson. For this we should trace back the finished product to its origin. Again the lesson on a port may have its origin from its trade. Another method is to trace back to its origin every article brought home from the retail shopkeeper. It will help them to feel that they are members of a larger world. It should be remembered that in teaching local geography to young pupils we are not to follow the regional method. Narration, description, excursion and observation prove more useful. The teacher should have two aims in view while teaching local geography :

(1) to emphasize the influence of site and location on the lives of inhabitants ;

(2) to show the influence of contacts made with the near and distant neighbours and to adduce the development of the native inhabitants.

One important question that faces the geography teacher of the primary classes is how to link this study with that of the sub-regions. The best way is to send out students to the neighbouring districts. It is because a neighbouring district is as much a foreign country for them as Europe or U.S.A. Thus students of Delhi may visit Nagpur and Calcutta. In this way the home district becomes a background of reality which will facilitate the formation of a true picture of distant areas. We usually start teaching of the regional geography of states in the 4th class because this is the most opportune time for its inclusion. It conveys the idea of man's relationship with his geographical environments beyond his daily life. Pupils will understand the meaning of the terms like cultivation, ploughing, irrigation, harvesting, spinning and weaving relating to textile industry. The teacher will realize that his early work in connection with local geography will greatly serve as an introduction to the principles of human geography which is defined as a "response in human activity of environmental conditions". Secondly, with the teaching of local geography (home district and homeland), pupils will form some ideas of regional geography, which is largely based on physical condition.

3. Weather Observation and Physical Geography

Observational work which has already been started in the kindergarten class will play an important part in the primary classes and onwards. Therefore nature study becomes indispensable. As soon as the points of compass are understood, pupils may read the weather-cock and record the directions of the wind. They may even construct a wind-vane. Rotation and revolution may be taught with the help of a plasticine model of a man standing on a slate globe which rotates before a lamp. While this topic is going on, the teacher may explain terms like Equator, Tropics, Arctic Circle and Antarctic Circle with reference to the position of the sun at the solstices. The terms Latitude and Longitude may also be explained here.

The next point to be emphasized is to divide the globe into five temperate zones. Let the child place his hand first flat against fire and then sideways and he will pick up the idea about the amount of heat at different places. As far as possible all instances which may arise in the course of teaching physical geography should be given from a study of local geography. Slate globe is a very good instrument for teaching physical geography. In the first place, children will learn from the slate globe, the names of continents and oceans and they will pick up examples of islands, bays, isthmuses, and peninsulas by relating them with their own models which have been prepared with reference to examples in the school locality. The slate globe will facilitate the understanding of the movements of earth. Even such abstract terms as Axis, North and South poles and the Equator will be easily understood. Once these geographical terms have been grasped, the study of the points of compass will not be a difficult thing. We can show how facing north and south means facing north pole and south pole respectively. We can ask pupils in what directiods lie Japan or America. In order to introduce realistic understanding, let children draw a line on the floor at noon along the shadow of a stick fixed vertically on the ground. This will give them South direction towards the sun and North away from it. A bisector of this will give East and West line. Their intermediate directions e.g., North East and North North East, etc. will not be difficult to draw. The next task will be to orient the objects in the class-room e.g. doors, windows and almirahs. Then go out of the room and orient the objects on the field i.e., entrance gate, hostel, headmaster's office, etc. After this eclipses may be taught with the help of two balls.

With the passage of time and with the growth of observation power made, the teacher should illustrate the directions and kinds of the wind prevalent in the region in different times of the year. They may also learn the elementary principles of weather. At intervals, pupils may be asked to measure the height of the midday sun and they may also note the time and direction of sun-rise and sun-set. It will be a good practice if the teacher encourages them to maintain a weather record. This will teach the general principles of Physical geography. After the directions have been learnt, the causes of wind and rain be dealt with next by referring to the rise of burnt scraps of paper after they are heated over the fire. The draught between the open air and the fire-place is a first hand example of the movement of winds and breezes. Similarly, we can proceed to the principle of water cycle with reference to daily observation by the pupils e.g., the drying of clothes. This will give them the meaning of the words "evaporation and condensation." The resultant formation of clouds and rain may be illustrated from the boiling of water in a kettle and the deposition of drops of water when ice is put in a tumbler. The teacher should point out how rivers are fed by rain and rivers in turn feed the sea, where from water is evaporated by the heat of the sun forming clouds and thereby it completes the water cycle. As far as possible, all quotations should be made with reference to a study of the homeland which would always accompany this work.

The causes of rainfall will lead to its results and we should then proceed to the study of the work of rain, water and rivers. Terms like water-parting, spring, and erosion are best learnt with the aid of models, pictures and other illustrative material. The working of a spring is best illustrated by putting a layer of porous sand on the top of plasticine or clay layer. To illustrate the erosive work of a river, muddy water may be collected and the sediment allowed to settle.

The formation of a delta may actually be demonstrated on the ground. Tides and estuaries may also be taught at this stage. The class should be taught how the rising and falling tides help the incoming and outgoing ships. It is suggested that the teacher must have surveyed the local area and thus he should present it in the form of a series of maps and models.

4. Map-work

Along with work on the slate globe will go exercises in map-work. These will consist of simple description of the school locality for locating the cardinal points for elementary map-drawing. It is a usual plan to introduce children of urban areas with 25″ to mile or 6″ to a mile map of the local district. In fact we introduce pupils with a map when they are able to recognize the geographical terms from the slate globe in relation to the models prepared by them. This will help them to know the meaning of the map which is a representative of the shape of the object when looked flat. The easiest way to proceed is to draw outlines of desks or tables and insert the work 'desk' in between the outlines, the resultant figure will be a map. If the figure of the outline of the table or plan as it is called, be reproduced on the black-board and pupils be told that diagram on the black-board is much smaller than that drawn on the floor, then the whole matter becomes quite clear. Similarly, the teacher can explain that the outlines of continents drawn on the slate globe are merely flat pictures of the continents. The next step is to distribute among pupils outline maps of the locality or the state drawn on the scale of 1″ to a mile and to explain them the convention by which North is always put at the top of the map. Some exercises may be given to show the direction in which some important places lie.

Another thing to be taught in connection with map work is the meaning of the 'scale' and its use. We have already explained that a map of a plan is always smaller than the area it represents and shows distance in addition to directions and shape. This is known as scale, meaning thereby that the distance on the ground measured in miles or yards or feet is represented on a paper or map by a length drawn in inches or centimetres only. Briefly, it shows miles in inches. In order to make more effective let pupils prepare a plan of the classroom and the school on some convenient scale. In order to add life to it some exercises be set on time-scale. For instance, how much time will you take in coming from your home to school moving at a particular speed. When the plan of the school locality has been prepared, let them fill in important features, identify them on the map and fill in their names. So much of map work is sufficient for the primary classes.

SPECIMEN SYLLABUS FOR THE PRIMARY CLASSES

The syllabus may be divided into 3 parts :—

1. Weather observation or nature-study :

It consists of nature-study and obser[illegible]ing to the following :

(a) The points of compass.

(b) The direction of permanent winds blowing in the region.

(c) A windvane.

(d) A weather record.

(e) Sun's height at different times.

(f) Conditions of weather at sunrise and sunset.

(g) Measuring rainfall, temperature and atmospheric pressure.

The theory portion may be taught with the help of a slate globe.

2. Physical geography :

(a) Causes of winds and rainfall.

(b) Water cycle and condensation.

(c) Work of rain, water and rivers.

(d) Springs.

(e) Tides and estuaries and their uses, etc.

The whole course in physical geography is to be taught with reference to the geography of the home state. The geographical terms which may arise in the study should be taught with the help of models of pictures.

3. Regional geography—People of the world : Home district and homeland (local geography).

The methods to be followed should be descriptive and observational. Models and pictures may be more liberally employed.

READING SCHEME IN REGIONAL GEOGRAPHY

1st Primary Class : Folk-tales of all kinds—These tales should present sufficient geographical background. These should be such as may be read by children themselves as well as those that may be read out by the teacher in the class.

2nd Primary Class : Stories of animals—These stories are recommended because animals reflect the geographical environment to which they belong. Besides, animals are of great interest to the children at this stage.

3rd Primary Class : Stories of the people—These stories should describe typical persons having supposed names like Ramu, the farmer and Raju, the miner. These should be written in a descriptive manner depicting the dignity of labour.

4th Primary Class : Stories of the people of India depicting the various geographical environment to which man has adapted himself.

In short, the Geography Reader should be readable and should produce a geographical atmosphere. It should, in the main, tell a story only and the lesson in geography should be a secondary object. The primary object is to cultivate geographical attitude.

13

Syllabus in Secondary Schools

The development of geography in India received great impetus as a result of the economic progress ushered in by the country's political independence in 1947. Significant progress has been registered in the training of geographer's specialities in the higher level educational institutions, where new plans of studies were put into operation. Of great interest is the initiation of geographic researches carried out by the geographical and non-geographical institutions. With regard to publications, apart from the periodicals of the various geographical institutions and societies, several text books concerning diverse branches of the subject of geography have been published. In other Asian countries, geography has a prominent place in some of the universities. In Europe, France and Germany were the first to develop the study of geography and have today many universities specialising in the geography of developing countries. Britain though started late, has almost caught up with France and Germany in matters of geographical research of the developing countries. In the East European countries, U.S.S.R. takes the lead in the study and research of geography In U.S.S.R. there are a number of universities which have well-equipped departments of geography.

The progress of modern scientific geography in India was very slow before partition and only the post-partition period showed a real growth of the subject due mainly to the interest taken by geographical and non-geographical research institutions, both in the public and private sectors. But much has yet to be achieved to develop the teaching of geography in schools and it is expected that more intensive efforts will be made in the near future. The study of scope, function and curriculum of geography in the school needs to be oriented according to the demands of the day. There is thus a strong plea for recasting of geography syllabus in Indian schools with a view to developing the concept of applied geography. It may be stated that the future of geography in India is well assured now that the theoretical and applied geography are deep-rooted on Indian soil. This is more so when the help of the geographers is being increasingly sought in various stages of urban and regional planning of India. If geography is to carry its useful purpose, the syllabus in a developing country, like India should be so framed as to bring it in line with the new requirement as the nation advances in confident strides. The emerging India is a challenge to the teachers of geography and to those concerned with education because the value of geography is increasing as India is growing in maturity and self-sufficiency. A detailed study of modern India necessitates a more diversified scientific knowledge of the whole system of scientific geographical discipline.

Geography is increasingly becoming a popular subject in the secondary schools of the country and it is offered by a sizeable number of students as a compulsory or as an effective course. The social studies approach may be utilized to some extent in the lower forms of schools but separate geography instruction in the senior forms is more important than the social studies approach in the curriculum. However, it is found that the position of geography in the school curriculum is most unsatisfactory because of the fact that the subject was considered to be a mass of unrelated facts, statistics and place names. A certain amount of memory work is, no doubt, essential in teaching of geography but it should be kept to the minimum. In primary schools the teaching of geography should be correlated with hand work, nature study and history, and in the higher forms of secondary schools it should be instructed as a distinctive science so that a planned continuity of geography teaching could be followed. The syllabus should be correlated with history but not to the extent of substituting it for history and geography. The syllabus in geography should be well-planned and standardised and may be changed and kept up-to-date to keep in conformity with the growing demands of the developing country. It is also unanimously agreed that the geographers should be trained as good teachers, researchers and professional workers. It is also urged that some aspects of political geography be included in the syllabus. The course material in secondary schools should be oriented towards physical geography and even though geography may have to be taught on regional basis, stress should be laid both on human and physical factors. The aspect of local geography should also be emphasized in the teaching of regional geography. The course material should start with immediate surroundings and then gradually should lead to the study of geography of other countries so that imagination of the children could be stimulated and the stock of knowledge enlarged. In syllabus, stress should be laid on home geography, human geography and observational geography because geography lends itself to be taught successfully through indoor and outdoor games, both of group and competitive types. Local geography has a significance in teaching of sense of unity and wholeness in understanding the subject.

The contents of course material for senior students should be such as to enable them to work with different kinds of learning resources and to get them involved in the thought-provoking problems. Stress should be laid on fundamentals as well as on the applied aspect of geography. The course material should be based on a settlement theme which will help students to discover, where and why people live and work, what they do and why and how people use and adjust their environments in diverse surroundings. These concepts are to be reinforced in succeeding years.

In a predominantly agricultural country like India, it is obvious that more attention should be given to agricultural geography. Hence, the study of urban geography has to be pursued at the senior school level to impart detailed information about the land use and functional zones of many urban centres of India. In addition, student may also be introduced to the topic of planning for resource development.

About theoretical geography it is now generally agreed by teachers that the neglect of physical geography leads to a serious impoverishment of the school course and that some period of continuous study of the main topics must be provided. The time taken by such studies does not impinge greatly on that required for teaching of regional and general geography. The interest that is thus aroused reduces the time required for frequent revision essential in other branches of the subject. The study of the land surface provides a unique opportunity of quickening the imagination and it is experienced that the interest of the adolescent pupils in the subject is proportional to the sense of wonder aroused by skilful presentation. With this initial interest provided by the study of physical geography, many concepts which find their place in advanced text books come within easy comprehension of young pupils and the task of the teachers becomes easy. The pressure on time is also reduced by the readiness of the pupils to read for themselves. This will also provide the pupils a life-long interest. Physical geography thus forms an essential part of the school geography syllabus.

The economic development of India requires an efficient planning which can only be achieved when the same is based on the scientific knowledge of physical facts and human phenomena. Cartography is an excellent medium for obtaining this indispensable basis. The teaching of cartography should be pursued at least at higher levels of the secondary schools. The teaching of cartography to school children is useful in other respects also because a greater part of modern life involves geographical aspects. Now-a-days much of the geographical information is continuously being presented through foreign daily papers, journals, magazines, radio and television programmes. Education should prepare the average citizen to understand the geographical problems presented to him through maps. Therefore, the curriculum of geography for schools should involve wider use of maps and atlases as source of geographical information. General topographic charts make available, with the desired precision and within the desired possibilities, the physical, natural and cultural aspects of the earth's surface. These charts are fundamentals to the elaboration of other cartographic forms and can be usefully included within the syllabus for secondary schools. The thematic charts contain the physical and human traits, or the relations between these environmental elements, and are useful at all levels. So elementary cartography should form a part of the curriculum.

Practical work has important role to play in developing geographical interest in the students of geography, especially important is the making of models for evaluating, appreciating and interpreting real life situations. Relief models form useful aids in learning and understanding geography and the students should be encouraged to prepare these to understand various geographical problems. The practical work imparts first hand geographical understanding and makes the subject lively. More accurate knowledge of geography can be obtained outside rather than inside the class room ; hence it is essential for a geography teacher to select the area for field work in the class syllabus. Before its operation, a teacher should keep in mind that a child observes a thing and tries to understand whereas an adult observes and seeks to interpret it.

The syllabus in the secondary school should be complete and well-balanced in all respects so that the major principles of geography are fully grasped and understood by the pupils. While syllabus is being prepared, it is necessary to know as to what portions of the subject matter land themselves to different methods of treatment suited to the particular mental stage of the pupil. It will be better if a greater part of the first year of the high school course is devoted to a detailed study of physical geography and other broader aspects of world geography and the second and third years are devoted to the application of these principles on regional geography. In the alternative, lessons from physical and regional geography may be followed. For actual class teaching the detailed procedure may be varied according to the needs of the teachers and pupils and exigencies of the school time table.

CONTENTS OF SECONDARY SCHOOL SYLLABUS

The secondary school syllabus may be comprised of three parts :

I. Physical Geography and Weather observations,
II. Regional Geography and
III. Map-Work.

I. Physical Geography and Weather Observations

There are two plans with regard to the teaching of physical geography. In some schools physical geography is started from the 5th class and is continued till the end. Another alternative plan is to postpone physical geography to the 9th or 10th class. The former plan is preferable. From the 5th class onwards we may begin to discuss the work of ice as an agent of erosion. We may also describe the phenomena of volcanoes, earthquakes and geysers.

At a still later stage broad principles of physical geography may be taught, e.g. the shape of the earth, its rotation and revolution, day and night, seasons, latitude and longitude, time and its relation to longitude, etc. These topics are postponed to the higher classes because they are difficult as they involve some mathematical knowledge. When sufficient knowledge about the composition of earth's surface is gained, rocks may be introduced. Similarly, an elementary study of oceanography like waves and currents may also be included. It is necessary that the principles of climate on which the superstructure of regional geography is based must be thoroughly grasped. For these reasons the distribution of pressure and wind on the earth forms an important feature of the course material. As the course proceeds in the senior classes, pupils will be able to take larger number of weather observations. The work should be started with taking records of temperature and pressure and, at intervals, of rainfall,too. Let these records be pasted on the notice board and graphs and other statistical diagrams prepared to show annual variations. This maintenance of records would lead to the the daily study of weather maps and weather forecasting. Practical work is profitable only if pupils can generalise broad principles, e.g. a sudden fall in temperature associated with heavy rainfall or a marked change in pressure with a change in wind.

II. Regional Geography

Once the junior course is finished, we have to direct our attention to the treatment of continents with increasing stress on the regional method. In these five or six years, the study of India should be specially emphasized against and outline study of the world as a whole. As the regional geography of Europe and North America is very complicated, it is advised to postpone their study to the later part of the course. Under these circumstances, three southern continents may be taken earlier. That the whole world must be taught is now agreed upon as most essential. It becomes very ticklish to decide which items in regional geography may be taken earlier and which ones later. The exigencies of the timetable and the examination make the same more complicated. Before entering upon the teaching of the geography of the individual continents, it is suggested that the world as a whole be studied in outlines particularly, from the point of view of human and economic geography. Such a step may be termed as the final stage of the transition period or the beginning of the Regional stage. This will serve three-fold aims.

(1) It prepares a background for a regional treatment of the continents by presenting a picture of the world of which they are a part. Pupils will come to know the relative positions of the continents and their broad characteristics. This elementary knowledge will greatly help in the study of individual continents later.

(2) It will level up the knowledge of the class about the world.

(3) It will awaken the interest of the pupil in the world around.

So far the child had been focussing his attention on his immediate surroundings.

To introduce the child to the world, any of the following methods may be found useful. It may be taught through the lives of the people or through the tales of travel or it may be through pupil's daily needs of food, clothing and shelter and the means adopted to satisfy them.

When the world study in outline has been introduced, each continent may be studied separately in relation to other continents. For example, Asia may be continued with Australia in the south and Europe in the west. Consequently these combined continents are also known as Australia and Eurasia, respectively.

Different teachers follow different order of treatment of the continents. As suggested above and as directed by the mental stage of the pupils, the three southern continents should always be taken earlier than Europe and North America. A word of caution is necessary with respect to the amount of attention to be paid to details in the regional study of the continents. Broad generalisations will not be possible in the junior classes but are necessary elements in the senior classes. The most important thing to be noted in the regional study is to draw the attention of pupils to the underlying geographical principles specially, the effect of relief, mineral resources, climate and soil in developing a great diversity in the occupation of man and in his standard of living. Such real problems of the world can only be approached by senior and not by junior *pupils* who study only the direct forms of human response.

ORDER OF TREATMENT IN THE REGIONAL STUDY OF CONTINENTS

The order of treatment of the world is extremely varied. In most cases, the study of India precedes and forms the bulk of first year's course. In other cases, Eurasia is taken in the 9th class, while the southern continents and North America are taken up later. Another plan is to study North America in detail. There also exists a concentric plan by which the same ground is covered in successive years with different emphasis and in greater details. The following plan based on psychological grounds is sometimes followed in many secondary schools.

COURSE A

1-4 years.

1. The preliminary stage.
   Home district.
2. The Transition Stage.
   (a) Extension of the home district,

	(b) Home State.
	3. The Regional stage.
5th class	(a) Introduction to the world and India in relation to world in outlines.
6th ,,	(b) Southern Continents.
7th ,,	(c) North America and Asia.
8th ,,	(d) Europe and Great Britain.
9th ,,	(e) India in detail and world in outlines.
10th & 11th ,,	(f) Study of the world as a whole from examination point of view.

Another plan based on logical grounds is also suggested.

COURSE B

1-4 years	1. The Preliminary stage. Home district.
	2. The Transition stage.
	(a) Extension of the home district.
	(b) Home stage.
	3. The Regional stage.
5th class.	(a) India in relation to world in outlines.
6th ,,	(b) America.
7th ,,	(c) Asia and Australia.
8th ,,	(d) Africa and Europe.
9th ,,	(e) India and World.
10th & 11th ,,	(f) Study of the above from the Examination point of view.

In course A the choice of three southern continents is based on relative simplicity of the physiographic structure and on its division into equal number of climatic provinces and also on the fact that economically, culturally and socially they are similar. Besides, pupils are very rich in memory, therefore full use should be made of this gift. For instance, pupils can very easily memorise details like rivers, towns, lines of communication, minerals and cultivated crops. In the following year less recourse is made to the memory work and, therefore, study of N. America based on climatic divisions is taken in hand. Then the treatment of the world continents concludes in the 8th or 9th class with the study of Eurasia, because at this stage pupils can appreciate the complexities of physical, economic and human geography.

Most teachers prefer course B. In this plan the world is divided into the northern and southern zones. North and South America are taken together in the same year ; Asia is taken with Australia and Africa with Europe. The merit of this plan is that major climatic regions are treated every year in greater details of the underlying principles.

III. Map-work

In junior classes it is suggested to introduce the meaning of the terms map and scale. We also set some exercises for their applications. Henceforth we shall begin map-work for teaching relief. Before taking up the contour lines method of showing relief, heights may be shown by shading. There are various methods in use to teach this difficult topic on contours, e.g.,

(1) Take a wooden model of a hill. Draw its contours and fix it on a central peg. Draw the outlines of each section of the contour on a piece of paper passed through the central peg.

(2) Take a photo of a contoured model of local area known to the pupils. If this photo is coloured in original it will turn out to be a contour map.

(3) The most reliable method is to project the picture of a contoured model on a screen by means of an epidiascope. Its appearance will be exactly that of an ordinary coloured atlas map. An attempt should be made to draw sections from the given contours. In order to explain this, the teacher will cut vertical slices of the contoured model. Sufficient practice should be given in this connection. In the early stages sections of very simple features should be drawn with the help of vertical and horizontal scales, e.g. across a conical hill, valley, a dip slope.

Another topic related to contours is how to read a map. Ground may be prepared for this before actual reading of the survey map is taken in hand. The teacher may ask pupils to draw the relief of the country through which they have passed while on excursion. Pupils should be asked to make use of the key to the layering. In the higher class some easy exercises in surveying may be set. The school playground may be surveyed by taking off-shoots from the base-line with the help of an optical square. Distances may be measured with the help of a chain or a tape. Use of field-book may also be explained. Then a fair plan be prepared from the data entered in the fieldbook. The last concern of the teacher in connection with map-work is the introduction of ordnance survey maps. Only elementary things about this topic should be attempted in the school classes

SPECIMEN SYLLABUS FOR A SECONDARY SCHOOL

I. Physical Geography or Physiography

A. The Globe or The Mathematical Geography:

Shape and size of the earth, movements of the earth and their effect (days, nights and seasons) directions, latitude and longitude, longitude and time.

B. Lithosphere :

(a) rocks,

(b) ice as an agent of denudation,

(c) volcanoes,

(d) earthquakes,

(e) geysers.

C. Hydrosphere :

Ocean and its movements, waves, currents, tides and their effect on climate and trade

D. Atmosphere :

Distribution of temperature, pressure and winds, land sea breezes, monsoons, trade winds and westerlies, their courses and effects, rainfall and climatic zones.

II. Practical and map work

A. 1. Introduction to scientific apparatus likely to be used in the course of study, e.g. thermometers, rain-gauge, and barometer.

2. Taking observations from these instruments and keeping records.

3. Representing statistical data in the form of statistical diagrams—curves, wheels and bar diagrams, etc.

B. 1. Making a map on a given scale.

2. Contours and section drawings.

3. Introduction to ordnance survey maps and exercises on them.

4. Introducing pupils to the simple processes of map making by surveying.

5. Conventional signs.

III. Regional Geography

5th class	India and world in outline.
6th class	Africa and South America.
7th class	Australia and Asia (including India).
8th class	Europe and North America.
9th class	India in relation to the world emphasizing economic and political developments.
10th & 11th class	Revision and solving University questions and study from the examination point of view,

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Geography Room and Museum and Their Equipments

Need of a separate geography room : Because of financial difficulties it is generally not possible for every school to have a separate geography room but it is desirable to have it and equip it with suitable geographical materials like maps, models, and other instruments. There are many advantages of having a separate geography room specially designed for that purpose. In the first place, much time and energy are wasted when maps have to be carried by the teacher from room to room. Secondly, the whole material is liable to be damaged and that will also involve unnecessary expense of time. Next, the black-board diagrams which accompany a geographical lesson cannot be preserved, for, a new lesson has to be given to the next class in the same class-room. Lastly, geography is a science subject and requires a geography workshop or laboratory of its own to create a congenial atmosphere for the subject which should stimulate the imagination and give inspiration to pupils.

Position and size : A geography room should have the minimum dimensions of 40 × 30 × 18 feet for a class of 30 pupils. A room with windows and doors on the south side is a necessity and it should open on to school field or a playground to enable the students to observe the natural phenomena like the sun and weather directly from the room. The room should, therefore, be large enough to enable pupils to walk about.

Equipments of the room : In the first place, care should be taken with regard to the lighting arrangements. The electric switch boards should be so fixed as to enable the teacher to light the whole or part of the room without unnecessary movement. Provision should also be made for lighting the black-board when the rest of the room has to be darkened for showing some slides. In order to darken the room at ease, the doors, windows and ventilators should be either fitted with wooden panels or with blinds coloured blue or black. Thus by pulling down the blinds the teacher can darken the room sufficiently for projection purposes.

Storage and wall display : All the space of the walls between dado and frieze may be utilized for black-board, lantern, and picture display. The black-board should run the whole length of one wall say, the east wall. Besides, one or two sliding black-boards should be graduated preferably with 2″ square incised rather than painted. The south wall should have two doors and one window to enable sufficient light to come in while the lesson is going on. Let there be two doors and two windows on the north side of the room.

Cupboard : On the eastern wall, where runs the black-board, let there be a low cupboard $3 \times 3\frac{1}{2} \times 2$ feet below the black-board fixed in the wall where appartus for projecting pictures and slides may be kept. An epidiascope or a magic lantern preferably the former, is used for reproducing illustrations from pictures, books, maps, to illustrate some particular points of the lesson. An epidiascope has an advantage over the magic lantern in that it can give the image of a solid object directly without necessitating the construction of a slide as required in the case of a magic lantern. There are various types of screens which can be used. A screen may be formed by distempering a part of the wall. Another kind of screen is a light rigid wood plank coloured white and hung from the ceiling by means of a string to be pulled up when not in use. By means of this apparatus it is possible for the teacher to direct the attention of the pupils both to the pictures displayed and to the black-board provided the epidiascope is placed on the teacher's table and is focussed on the screen fixed on the opposite wall.

Show case : At the other end of the black-board may be fixed either a show-case or a cupboard $1\frac{3}{4}' \times 2' \times \frac{1}{2}'$ for specimens of rocks. These rock specimens should be properly labelled. It is necessary that the show case should be glazed and not panelled. In between these cupboards should hang stencils of continents cut out in tin or cardboard or thick cloth of plywood. With the help of these stencils the teacher can draw the outlines of the continents on the black-board very conveniently and quickly.

Teacher's table : In front of the black-board should stand the teacher's table which should be sufficiently strong and durable and large enough for the display of illustrative materials of a geography lesson. If possible, one end of the table may have a sink. It should also be fitted with drawers and storage space.

Pupil's desk : The pupil's desk placed opposite the teacher's table with some space left in between the two be strong and flat topped having drawers, if possible. Stools or chair may be placed for the students to sit on. Tables may be fixed or $3\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ feet. At one corner of the room let there be a tracing table fitted with electric bulbs and its top made of annealled glass. Along the black-board wall in a corner be placed a vertical map-stand to display wall maps.

Map cupboards : The map-cupboards which are placed on the north side are of various types. The most common type is an almirah having a single shelf with big round holes grooved in it. In these holes are placed vertically rolled maps. Another form may take the shape of a chest drawer almirah 5½×3½×2 feet in which are placed horizontally rolled maps. Sometimes in another type of map cupboard hooks are screwed at the top of the cupboard and maps are then vertically hung by means of rings fixed into the ends of the rolled maps. Such a cupboard occupies very little space and maps are kept quite clean and are easily traceable. Another form of a map-stand in use in school is the one fitted with brackets for the rolled maps to stand on. On the top of these cupboards are placed globes. The cupboard on the north wall should be of higher dimensions 5½′×4½′×2½′ and be provided with shelves and drawers. These shelves will contain pictures, sildes and other apparatus arranged in a systematic manner.

Astronomical and Meteorological Instruments: The other articles to be placed in the same cupboard are astronomical and meteorolgical instruments, wired globe protectors, compass, black-board rules and models, etc. Astronomical instruments consist of various types of orreries for teaching the astronomical part of geography—like the earth as a planet. The meteorological instruments include the maximum and minimum thermometers, wet and dry bulb thermometers, barometer (Aneroid), windvane and rain-gauge. The teacher should get weather reports of local area prepared with the help of these instruments. With the help of the ruler the teacher can very easily prepare statistical diagrams to illustrate crop production, exports and imports, etc.

Library: Against the wall lying between the two doors on the south should be placed two big almirahs for geography books. This will serve the purpose of a geographical library. These almirahs should not merely be packed with text books on geography but should also include books on travel and other illustrated and descriptive books. Picture books are a necessary addition on account of their great appeal to young pupils. A geography library should also contain some advanced books for intelligent students and for the use of the teacher. The Statesman Year Book and Whitaker's Almanac are useful additions to any library. Although these reference books are a great necessity, yet the importance of the text books should not be overlooked by the teacher.

Picture railing: Lastly a picture railing may be fixed all round the room well above the doors except in the space used as a screen. This railing should be fitted with books for picture showing life in different parts of the world, e.g.. pictures of Egyptian Desert, Niagra Falls, Suez Canal, Panama Canal, Amazon Basin, Congo Basin and Tundra Region, etc. Below the railing may be hung framed pictures drawn and collected by pupils themselves.

Equipment of Geography Museum: There is a large variety of objects which may be preserved in a geography museum. The following are the most important :—

1. Pictures. picture post-cards and paintings illustrating the life of the people in various parts of the world.

2. Models of clay or clay plasticine either made by children or purchased from the market, exhibiting life in other lands or illustrating some geographical terms of phenomena.

3. Locally manufactured articles such as cloth, pottery, wood and metal works, basket work, lacquer work.

4. Specimen of agricultural crops, e.g., rice, millet, wheat, gram, maize, peas, oil-seeds and fibres.

5. Different kinds of rocks, stones and minerals. It is desirable that each specimen be labelled and some account of the areas of availability should also be written.

6. Foreign stamps, coins and pamphlets.

In general, selection should be made of those objects which have a meaning to the lives of the pupil. The best occasion for collecting objects is when the pupils go out on some excursion. It is a better plan if the whole work is divided on the basis of division of labour. Let one pupil confine oneself to the specimen of one type of rock, and the other to another type. The third pupil could collect pictures on physical geography and the fourth may collect a type in timber. Let the specimens collected illustrate some particular point or stage of the manufactured articles, e.g. steel, cotton or wool. The teacher should aim at having a complete set of articles. Lastly, the geography museum should be easily accessible to every pupil in the class. Consequently, the show cases in which these articles are placed should be fixed up at convenient places. It will be necessary that these show cases be 6 x 3 x 4 feet and fitted with glass tops and sides. As far as possible no body should be allowed to mishandle them. Regular dusting is necessary.

A geography meseum will be a great success if certain principles are kept in view. A geography museum is not the only concern of the geography teacher but, let every boy or girl take some part in it by taking personal interest in its maintenance and uptake. A museum is likely to flourish if management rest with a museum committee of students working under the guidance of a kind and sympathetic teacher. In this way, every boy or girl will feel a natural pride in his or her own exhibits. It is natural that the museum gets dusty and the contents damaged and become out of date. To avoid the exigencies the museum should be cleaned periodically and every damaged article should be suitably replaced. Once a museum has been set up, it becomes a permanent feature. It does not need much replacement. Above all it becomes a constant source of enjoyment, interest and instruction to those whom it intends to benefit.

PART II

PHYSIOGRAPHY

INSTITUTE OF EDUCATION FOR WOMEN
Deptt of Extension Services.
CALCUTTA-27

15

The Earth and The Seasons

The Position of the Earth in Space

The earth and a number of other heavenly bodies revolve round the sun as their centre. Arranged in order of their distance from the sun, they are ;

(1) Mercury,
(2) Venus,
(3) Earth,
(4) Mars,
(4) Jupiter,
(6) Saturn,
(7) Uranus,
(8) Neptune and
(9) Pluto.

Of these planets Jupiter is the largest and is 1,400 times the size of the earth. Mercury and Venus are both smaller than the earth. The former is the nearest to the sun, while the latter is the

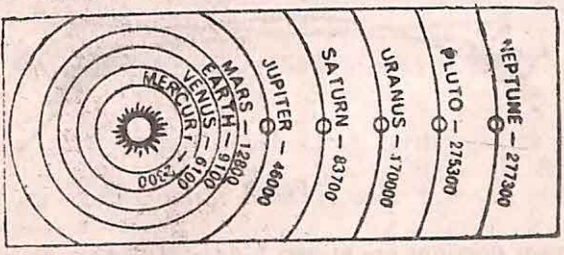


Fig. 1. The Planets.

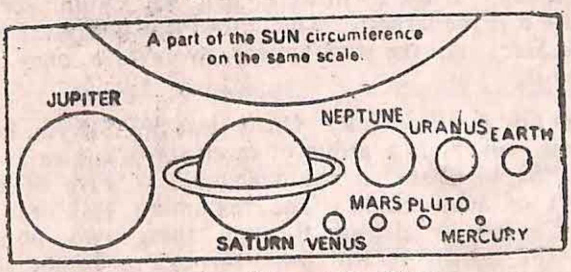


Fig. 2. Planets Comparative Sizes.

nearest to us and therefore appears to be the brightest of them all. It can easily be seen just after sunset or before sunrise, when it is known as the evening star or the morning star accordingly. (Figs. 1 and 2).

The Shape of the Earth

The earth is round like a ball, slightly flattened towards two opposite points and is pear-shaped rather than orange-shaped. In scientific language it is called an oblate spheroid, i.e. a flattened sphere. It appears to be flat, because only a small part of it can be seen at one time. That it is actually round is proved by the following facts :—

(1) If we travel northward or southward from any place, the position and path of the stars are altered ; new stars come into view as we proceed, while others disappear behind us. This can happen only on a sphere.

(2) The sun rises earlier for places to the east, and later for places to the west. (Compare the time of sunrise for Calcutta, Delhi, and Kanpur on any date). Had the earth been flat, the sun would have been visible at the same time at all places.

(3) When a ship is sailing towards the land we see the top sails first, next the masts, and last of all the hull or body of the

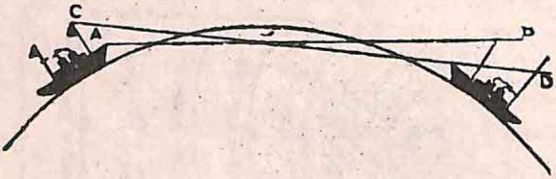


Fig. 3

ship. The lower portions are at first hidden from view by the curved surface of the sea. If the earth were flat, we should see the hull first, because it is the largest. This proof was first given by *Strabo* *Star or Pole Star*. All the stars appear to revolve once a day in circles round it.

How to find the Pole Star. On a clear night if you look at the heavens, you will find a group of seven starts known as the Great Bear (called Sapta Rishi in the vernacular). Five of these stars make a sort of semi circle. The remaining two are known as Pointers. If a line be drawn through these two pointers and produced to the north, it will pass through a bright star. This star is called the Pole Star (in India Dhruva Tara or Qutb). It always directs us to the north and, is visible only in the northern hemisphere. (Fig.4)

Equator. The imaginary line drawn round the earth midway between the poles is called the Equator. The axis of the earth is inclined to the plane of the orbit at an angle of 66½°. The Equator divides the surface of the earth into two equal parts, each of which is called a Hemisphere.

Altitude of the Sun. This is the height of the sun from the earth measured in degrees.

Plane. A plane is a perfectly flat area. As a line is defined as length without breadth, so a plane is length and breadth without thickness or elevation.

Orbit. The Orbit is the path of the earth or other planet round the sun.

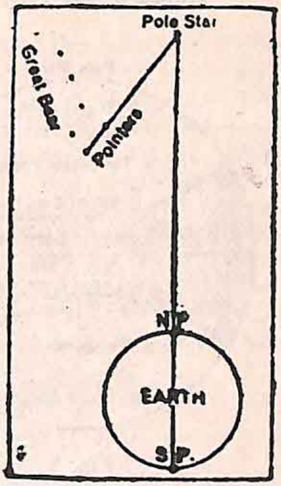


Fig. 4 Position of the Pole Star.

Plane of the Orbit. This is the plane in which the orbit lies.

Zenith. This is the point in the heavens which is exactly over our heads.

Nadir. This is the point in the heavens which is directly under our feet.

Antipodes. The opposite side of the earth to us is called our Antipodes. (Greek anti, opposite ; podes, feet). It is so called because people walking on the earth at that point have their feet turned towards our feet.

Horizon. This is the great circle round us where the earth and the sky seem to meet. The higher we stand, the greater the horizon becomes.

Tropic of Cancer is an imaginary line drawn round the earth 23½° north of the equator.

Tropic of Capricorn is an imaginary line drawn round the earth 23½ south of the equator.

Arctic Circle is an imaginary line drawn round the earth 23½° south of the north pole.

Antarctic Circle is an imaginary line drawn round the earth 23½° north of the south pole.

Zones of the Earth. The areas of the earth bounded by these four circles are called Zones or Belts, and are named from the general nature of their climate. The belt between the tropics is called the Torrid Zone, as it is the hottest as a whole. The areas round the poles are called the north and South Frigid Zones, as they are the coldest. The intermediate areas are called the North and South Temperate Zones. (Fig. 5)

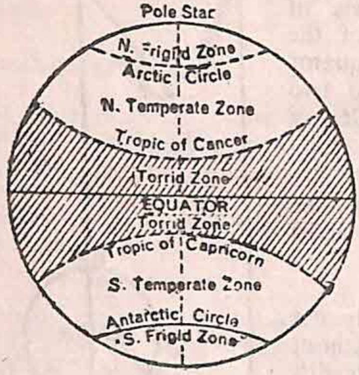


Fig. 5.

The Motions of the Earth

The earth has two motions, Rotation and Revolution. Let us consider them in detail.

1. The Rotation of the Earth

We daily see that the sun rises in the east, passes over our heads, and sinks in the west, to re-appear next morning. Thus at first sight it appears that it is the sun which is moving round the earth. But it is not so. Just as when we are sitting in a fast train the objects outside seem to run in the opposite direction to that in which the train is moving, in the same way the sun appears to move from east to west on account of the turning of the earth on its axis from west to east in 24 hours. The daily turning of the earth on its axis is called the Rotation of the Earth.

The effect of the Earth's Rotation

(a) *Day and Night.* If you bring a rubber ball before a burning lamp, you will observe that in whatever position you place it, half of it is always in light, and the other half in darkness. This is because the ball is opaque, that is light cannot pass through it. If you rotate the ball, you will observe that not only is half of it in light and the other half in darkness, but that each part of it successively comes into the light, remains there for a while, and then passes into darkness. The earth, like the ball, is opaque and exactly in the same way rotates on its axis from west to east in front of the sun. The part of the earth which is towards the sun is in the light and has its day, while the part away from it, is in darkness and has its night. Thus day and night are caused by the earth's rotation.

(b) As we shall see later, rotation is one of the causes of the tides of the ocean and affects ocean currents.

2. The Revolution of the Earth

Just as there is an apparent daily motion of the sun, so there is an apparent yearly motion of the sun. On 21st March and 23rd September, it rises exactly in the east and sets in the west.: but from 22nd March to 22nd September, it rises a little north of east and sets a little north of west and from 24th September to 20th March, it rises a little south of east and sets a little south of west. Again, the altitude of the sun at noon is not the same throughout the year. On 21st June, it is the highest and on 22nd December, it is the lowest. These yearly changes in the position of the sun are not due to any motion of the sun itself, but are due to the revolution of the earth round the sun in 365 days, with its axis inclined to the plane of its orbit at an angle of 66½ degrees and always pointing in the same direction.

Thus the earth has two motions simultaneously :

(1) the rotation on its axis in 24 hours, and

(2) the revolution round the sun in 365 days.

The effect of the Earth's Revolution

We have just said that the axis of the earth makes an angle of 66½ degrees with the plane of its orbit. Suppose for a minute, it is at right angles to the plane of its orbit as shown in Fig. 6. What do we find ? We find that NS, that is the line which divides the light half from the dark half coincide with the axis ; LM is equal to MP ; QQ is equal to OR ; CD is equal to DE. Thus L (Lucknow) in the northern hemisphere, Q (Quito) on the equator, and C (Cape Town) in the southern hemisphere, remain half the time in light and half the time in darkness. In this position, therefore, as the earth rotates and revolves, days and nights are equal all over the surface of the earth. The sun always rises due east, sets due west, and remains at noon at a particular place at the same height throughout the year ; consequently there is no change of seasons. But these facts go against our actual experience. Therefore the axis of the earth cannot be perpendicular to the plane of its orbit.

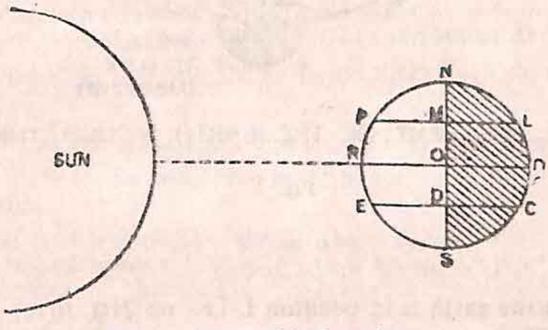
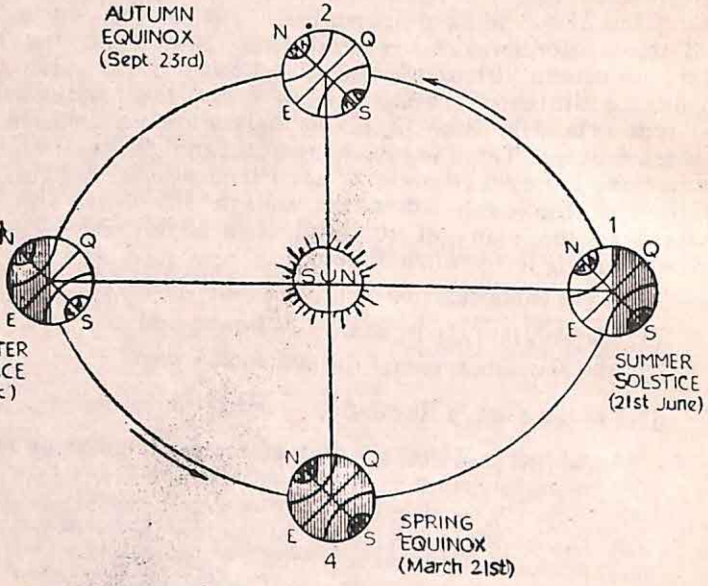


Fig. 6 What might have been

Now look at Fig. 7 in which the axis of the earth is shown as inclined at an angle of 66½ degrees to the plane of its orbit no matter what the position of the earth with respect to the sun may be.


AUTUMN EQUINOX (Sept. 23rd)
2
N
Q
E
S
N
Q
3
E
S
WINTER SOLSTICE (21st Dec.)
SUN
1
N
Q
E
S
SUMMER SOLSTICE (21st June)
N
Q
E
S
4
SPRING EQUINOX (March 21st)

THE MOVEMENT OF THE EARTH ROUND THE SUN

Fig. 7

Position I

When the earth is in position I, i.e., on 21st June, we observe the following :

(1) The north pole is inclined 23½ degrees towards the sun while the south pole is 23½ degrees away from it.

(2) The rays of the sun not only reach the north pole but also shine for 23½ degrees beyond it, while they fall short of the south pole by the same distance.

(3) The sun is vertical over the Tropic of Cancer, i.e. at all places 23½ degrees north of the equator.

(4) Although the earth rotates on its axis, the area from *a* to *b* round the north pole remains in light, while the corresponding area from *c* to *d* round the south pole is in continuous darkness.

(5) Any place in the northern hemisphere will remain in the light for more than half the time of rotation i.e., it has longer days and shorter nights.

(6) Any place on the equator remains for half the time in light and half the time in darkness i.e., it has days and nights equal.

(7) Any place in the southern hemisphere remains longer in darkness than in light i.e., it has longer nights and shorter days.

(8) It is summer for the northern hemisphere and winter for the southern hemishere. This position of the earth is called the Summer Solstice (Latin sol, sun ; stare, tost and), because the sun seems to stop or pause before returning.

Position II

When the earth has made half its revolution and come to position II, i.e. on 21st December, the conditions are reversed.

(1) The south pole is inclined 23½ degrees towards the sun while the north pole is 23½ degrees away from it.

(2) The rays of the sun not only reach the south pole, but also fall for 23½ degrees beyond it, while they fall short of the north pole by the same distance.

(3) The rays of the sun fall perpendicularly on the Tropic of Capricorn i.e. at all places 23½ degrees south of the equator.

(4) The area round the south pole remains in continuous light, while the area round the north pole is in continuous darkness.

(5) Places in the northern hemisphere have shorter days and longer nights.

(6) Places on the equator have days and nights equal.

(7) Places in the southern hemisphere have longer days and shorter nights.

(8) It is summer for the southern hemisphere and winter for the northern hemisphere. This position of the earth is called the *Winter Solstice.*

Positions III and IV

When the earth is in position III and IV i.e. on 23rd September and 21st March respectively, we find the following :

(1) The circle of light passes through the poles.

(2) The rays of the sun at noon fall perpendicularly on the equator.

(3) Days and nights are of equal duration everywhere.

(4) When the earth is at III, it is spring for the southern hemisphere and autumn for the northern hemisphere. This position of the earth is called the Autumnal Equions (Latin aequus, equal ; nox, night).

(5) When the earth is at IV, it is spring for the northern hemisphere and autumn for the southern hemisphere. This position of the earth is called the *Vernal* or *Syring Equinox.*

Conclusion :

From the above explanation we see that, as the earth revolves round the sun in 365 days with its axis inclined 66½ degrees to the plane of its orbit and always pointing in the same direction, the duration of day and night regularly increases and decreases and the altitude of the mid-day sun regularly changes. Therefore the amount of heat received from the sun varies during the course of the year, and thus we get a cycle of seasons. From all that has been said above we can now briefly state the effects of the earth's revolution and inclination of its axis :

(a) Varying length of day and night.

(b) Varying altitude of the sun at noon.

(c) The changes of the seasons which are the result of (a) and (b).

(d) The apparent movements of the sun and planets among the fixed stars.

Factors upon which the amount of heat received from the sun depends

The amount of heat received from the sun at any place on the earth's surface depends mainly upon two things, the length of the day and the altitude of the sun :

(*i*) *The time during which the place is exposed to the sun.* In summer the days are longer than the nights, therefore the earth receives more heat during the day-time than it can receive during the night.

(*ii*) *The direction of the rays falling on the place.* The vertical rays are much hotter than the oblique rays for two reasons :

(a) The vertical rays have to pass through less atmosphere than the oblique rays and thus lose less of their heat than do the slanting rays.

(b) The vertical rays are spread over less area than the oblique rays and thus produce greater heat than the slanting rays (Fig. 8).

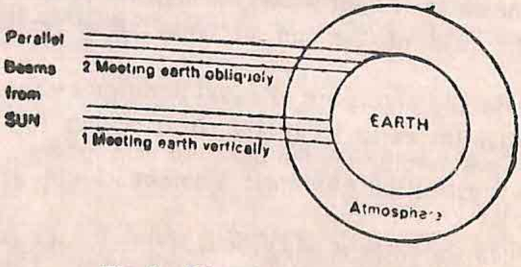


Fig. 8. Direction of Sun Rays

At noon, the rays of the sun are more nearly vertical than during the morning and the evening. Therefore the mornings and evenings of a place are less warm than the noon.

Similarly, in summer, the rays are more nearly vertical than in the winter. Therefore the summers are hotter than the winter.

The distance of the sun from the earth at different times has little effect upon the amount of heat received. The earth, as you know, revolves round the sun, not in a circle, but in an ellipse (see Fig. 7). Therefore the earth is sometimes nearer to the sun than it is at other times. The minimum distance in December is 91,250,000 miles, and the maximum in June is 94,500,000 miles. But this difference of distance is comparatively so small that the greater distance from the sun does not lesson the heat to any perceptible degree.

Perihelion is the position of the earth, in its orbit when it is at its nearest to the sun this takes place during the northern winter. Aphelion is the position of the earth in its orbit when it is at its greatest distance from the sun. This takes place during the northern summer.

July hotter than June and Afternoon hotter than Noon

The northern hemisphere receives the greatest amount of heat on 21st June, because that day is the longest and the altitude of the sun is the highest. But the highest average temperature takes place at some time after that date. Similarly, on 21st December the day is the shortest and the altitude of the sun is the lowest, therefore the amount of heat received is the least. But the lowest average temperature takes place after the date. What is the reason ? The reason is that the northern hemisphere is gaining (receiving more than it radiates) heat most rapidly after 21st June, and it continues to gain heat, though to a less extent, for some time afterwards. Similarly, the northern hemisphere is losing heat most rapidly on 21st December, and this continues to a less extent for some time afterwards. In a corresponding way, the hottest time on a summer day is not noon, but the afternoon ; and the coldest time in the winter is not midnight, but after midnight.

Midnight Sun

A phenomenon of high latitudes observed at and around midsummer, when the sun does not sink below the horizon throughout the 24 hours, and therefore may be seen at midnight, it is due to the inclination of the earth's axis to the plane of the "Ecliptic", and the consequent tilting of each hemisphere towards the sun during its summer. At North cape, Norway, just north of 73° N latitude, for instance, at least part of the sun's disc is continuously visible, day and night from May 12 to July 29.

Twilight

When the sun is rising or setting, that is, when it is a little below the horizon, the upper layers of the atmosphere are exposed to direct sunlight, which is there reflected and dispersed by the dust and water particles contained in the air. This diffused light reaches the earth and is called Twilight (literally "two lights," those of the day and night). Had there been no atmosphere round the earth there would have been no twilight. Sunset would then have been like the putting out of a lamp in a dark room. There would have been neither dusk nor dawn.

16

Latitude, Longitude and Time

How to determine the position of a place on a Plane or Flat Area

In Fig. 9 ABCD is a field, in which X is a tree. The position of the tree is to be determined. Through X draw XR perpendicular to BC. Measure XR; say it is 4 yards or 3.7 metres. But this is not sufficient to enable us to locate the trees exactly, for there can be several trees 4 yards or 3.7 metres from the line BC. Now draw XR perpendicular to AB. Measure it; say it is 4.6 metres. Now there is only one tree that is 3.7 metres from the southern boundary of the field and 4.6 metres from the western boundary.

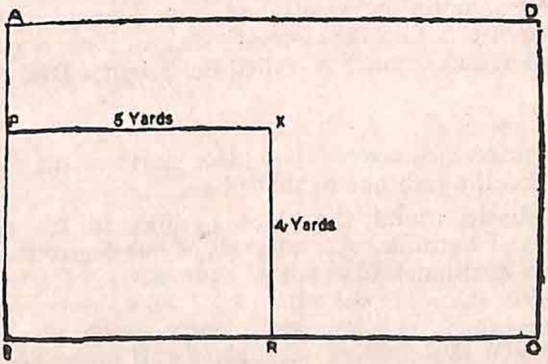


Fig. 9. Fixing Position on a Plane

Thus in order to fix the position of a place on a flat area, it is necessary to know its perpendicular distance from two fixed lines. The fixed lines (AB and BC in this case) are called the Axes of Reference and the point where they intersect (B in this case) is called the point of Origin.

How to Locate a Place on a Sphere

To fix the position of a place on a sphere, two similar fixed lines or axes of reference, from which its distance may be measured, are necessary. One such fixed line is the Equator (see previous definition). The other fixed line is one of the Meridians. What is Meridian ? A Meridian (Latin meridies, mid-day) is the semi-circle drawn from the north pole to the south pole, cutting the equator at right angles. It is so called because all places situated on it have their midday or noon at the same time. There are 360 meridians, but only one fixed or Prime Meridian to measure from. Various nations have different prime meridians. The meridian which passes through the Royal Observatory at Greenwich is the prime meridian for the United Kingdom and most other countries. The French for the same purpose use the meridian which passes through Paris as their prime meridian.

Now distance can be measured north or south of the equator and east or west of the prime meridian. The point where the equator and the prime meridian intersects will be the point of origin on the sphere. (Take a rubber ball and mark on it the equator and the meridians.) But remember that distance on a sphere is not measured in miles, yards and feet, but in degrees, minutes, and seconds. It is therefore called the Angular Distance.

Angular Distance

The circumference of a circle may be divided into 360 equal intervals or parts, whether the circle is large or small. The angle which one of these parts subtends at the centre of the circle is called a degree (*written*°), or 1/90 of a right-angle. Each degree may be divided into 60 minutes (*written*′), and each minute into 60 seconds (*written*″). The distance on the circumference of a circle measured in degrees, minutes, and seconds is called the Angular Distance.

Latitude

The angular distance of any place north or the south of the equator is called the Latitude of that place.

Circles drawn round the globe parallel to the equator are called Parallels of Latitude. At intervals of one degree there are 180 such circles, 90 north and 90 south of equator.

Longitude

The angular distance of any place east or west of the Prime Meridian is called the Longitude of that place. The 360 meridians or half circles are called Lines of Longitude. Thus we know the position of any place on the earth when we know its latitude and longitude.

Latitude is measured—

—in degrees up to 90° north or south ;

—along the meridian of the place ;

—from the equator ;

—to the parallel of latitude of the place.

Longitude is measured—

—in degrees up to 180° east or west ;

—along the parallel of latitude of the place or along the equator ;

—from the meridian of Greenwich ;

—to the meridian of the place.

Value of a Degree of Longitude and of Latitude in miles

All the lines or circles of longitude are of the same size, as each of them goes through the poles and runs right round the earth. Each is therefore called a Great Circle, because it is the largest circle that can be drawn round the earth and each meridian is half of a great circle. As all of these circles converge towards the poles, and are farthest apart at the equator, the distance covered by one degree of longitude grows less and less as we proceed from the equator to the poles. From this we see that the value of a degree of longitude varies according to the latitude. At the equator it will be 1/360th of the earth's circumference (which we know is about 24,900 miles) and is therefore equal to about 69 miles. At the poles, since all the meridians meet there, a degree of longitude is zero and has no length. At the intervening degree of latitude its length will be as follows :

At 10° it is about 60 miles.
At 20° ,, ,, 65 ,,
At 30° ,, ,, 60 ,,
At 40° ,, ,, 53 ,,
At 50° ,, ,, 45 ,,
At 60° ,, ,, 35 ,,
At 70° ,, ,, 24 ,,
At 80° ,, ,, 12 ,,
At 90° ,, ,, 9 ,,

On the other hand, each of the parallels of latitude is clearly at one uniform distance from the equator and from any other parallel of latitude : If the earth were a perfect sphere, a degree of latitude would therefore be everywhere of the same length. But owing to the flattening near the poles, a degree of latitude is slightly longer there. We may, however, disregard this small difference, and take the length of a degree of latitude as 69 miles approximately. It should be remembered that while all circles of longitude are of the same size, the parallels of latitude become smaller as we approach the poles. All parallels of latitude (except the equator) are Small Circles ; the equator is a Great Circle.

How to Find the Latitude of a Place ?

(i) In figure 10 let ADBE be the earth, AB the equator, DE the axis and DAE the meridian of the place L situated on it. Join

OL and produce it to Z, Z is then the zenith of L. Draw HH′ perpendicular to ZL. Then HH′ is the horizon of L. Through L draw

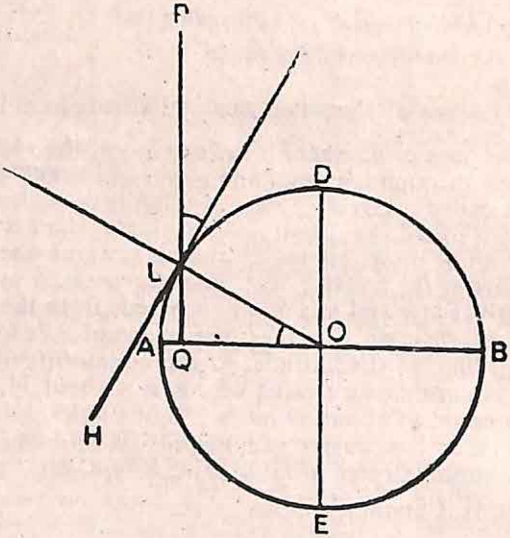


Fig. 10. How to find Latitude

PQ parallel to DO, which is the direction of the celestial pole or pole star. Thus the altitude of the pole star is PLH and the latitude of L is LOA. As PQ is parallel to the perpendicular DO, therefore QLO is a right-angled triangle. Thus angle PLH′ plus angle ZLP is equal to vertical angle ZLQ; therefore angle PLH′ is equal to angle LOQ. Thus we see that the altitude of the Pole star is equal to the latitude of the place.

This we can also see in another way. The height of the Pole Star is 90 degrees at the north pole and the north pole is 90 degrees from the equator. Therefore at the equator, the height of the Pole Star is 0°. At 1 degree north, the height of the Pole Star will be 1 degree, and so on. Suppose the height of the Pole Star at Nasik is 20 degrees the latitude of Nasik will consequently be 20 degrees.

The altitude of the Pole Star is exactly found by means of an instrument called a Sextant. Remember, that this method of finding latitude is applicable only to places situated in the northern hemisphere, as the Pole Star is visible only in the northern hemisphere.

(ii) On 21st March and 23rd September the midday sun is vertical at the equator. Its height at the poles will be 0°. Hence the latitude of any place on these dates will be equal to 90 degrees minus the altitude of the midday sun of that place, which can be determined by the sextant. Suppose the height of the midday sun at Nasik on 21st March or 23rd September is 70 degrees, the latitude of Nasik is 90 degrees minus 70 degrees, or 20 degrees.

Local Time

The circumference of the earth is divided into 360 parts or degrees. As it goes round on its axis once in 24 hours, its surface moves at the rate of 15 degrees an hour, or 1 degree in 4 minutes. As it rotates from west to east, the sun rises earlier for places to the east and later for places to the west. Suppose it is noon at Greenwich, it will be afternoon at places situated to the east of Greenwich, and forenoon at places west of Greenwich. Therefore when it is noon at Greenwich it will be 12-4 P.M. (post meridiem=afternoon) at Canterbury, situated 1 degree east of Greenwich, and 11-56 A.M. (ante meridiem=before noon) at Reading, situated 1 degree west of Greenwich ; 6 P.M. at Dacca, situated 90 degrees east of Greenwich, and 6 A.M. at New Orleans, situated 90 degrees west of Greenwich.

Rule to Find Local Time

From the above explanation, we deduce the following rule for finding the local time of a place when the longitude of the place is given :—

For the places east of Greenwich add four minutes to the Greenwich time for every degree of longitude.

For places west of Greenwich subtract four minutes from the Greenwich time for every degree of longitude.

Examples

(1) What is the time at Madras, 80 degrees east longitude, when it is noon at Greenwich?

For one degree of longitude there is a difference of 4 minutes; for 80 degrees there is a difference of 80×4 Minutes=320 minutes, or 5 hours and 20 minutes. As Madras is situated to the east of Greenwich 5 hours and 20 minutes should be added to the Greenwich time. Therefore the time at Madras will be 5-20 P.M.

(2) Find the time at Quito, 78 degrees W, when it is noon at Greenwich.

For one degrees longitude there is a difference of 4 minutes, for 78 degrees there is a difference of 78×4 or 312 minutes, or 5 hours and 12 minutes.

As Quito is situated to the west of Greenwich 5 hours and 12 minutes should be subtracted from the Greenwich time. Therefore the time at Quito will be 6-48 A.M.

(3) What is the time at Peshawar, 71 degrees E., when it is 1 P.M. at Tokyo, 139 degrees E. and vice versa ?

The difference of degrees of longitude between Peshawar and Tokyo is equal to $139° - 71° = 68$ degrees.

For one degree there is a difference of 4 minutes; for 68 degrees there is a difference of $68 \times 4 = 272$ minutes, or 4 hours and 32 minutes.

As Peshawar is situated to the west of Tokyo 4 hours and 32 minutes should be subtracted from Tokyo time. Therefore the time at Peshawer will be $13-(4\text{-}32)=8\text{-}28$ A.M.

Again, as Tokyo is to the east of Peshawar, the time at Tokyo will be $1+(4\text{-}32)=5.32$ P.M. when it is 1 P.M. at Peshawar.

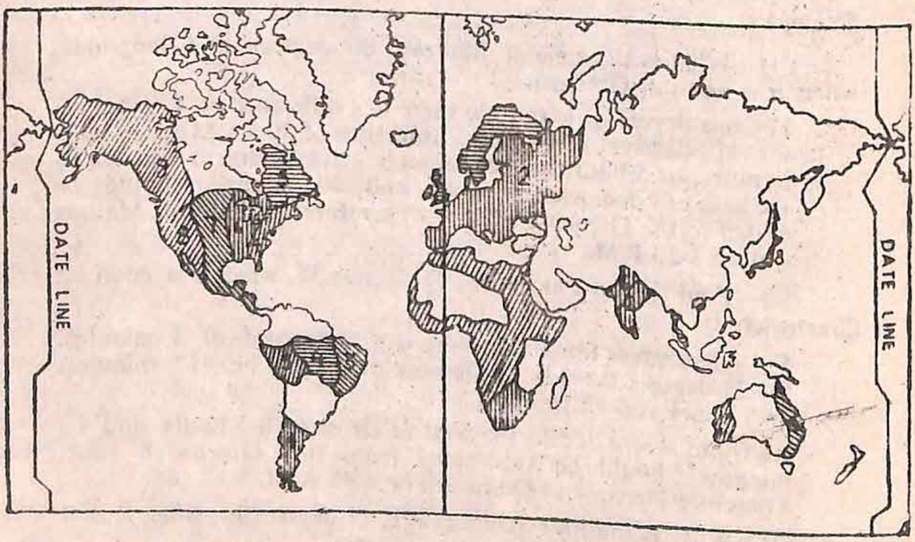
(4) Find the time at New York, 74 degrees W. when it is Thursday 2 A.M. at San Francisco, 122 degrees W; and vice versa.

The difference of degrees of longitude between New York and San Francisco is equal to $122° - 74° = 48$ degrees.

For one degree there is a difference of 4 minutes; for 48 degrees there is a difference of 48×4 or 192 minutes, or 3 hours and 12 minutes. As New York is situated to the east of San Francisco 3 hours and 12 minutes should be added to the San Francisco time. Therefore the time at New York will be Thursday 5-12 A.M.

Again, as San Francisco is to the west of New York the time at San Francisco will be $14-(3\text{-}12)=10\text{-}48$ P.M. Wednesday, when it is Thursday, 2 A.M. at New York.

(5) What will be the time at Lahore, 74 degrees E., when it is Monday 6-15 P.M. at Chicago, 87 degrees W; and vice versa ?



The difference of degrees of longitude between Lahore and Chicago is equal to 74°+87°=161 degrees. For one degree there is a difference of 4 minutes; for 161 degrees there is a difference of 161×4, or 644 minutes or 10 hours and 44 minutes.

As Lahore is situated to the east of Chicago 10 hours and 44 minutes should be added to the Chicago time. Therefore the time at Lahore will be (6-15)+(10-44)=16 hours and 59 minutes=4-59 A.M. Tuesday.

Again, when it is 6-15 P.M. on Monday at Lahore the time at Chicago will be 18-15 minus 10-44, or 7-31 A.M. Monday.

Standard Time

As the local time at each place is different, it would be very inconvenient if every town were to keep its own local time. To avoid this inconvenience, the local time of one important place is adopted throughout a large area. This time is known as the Standard Time. The whole of the United Kingdom takes its standard time from Greenwich. Ireland takes its time from Dublin, which is 25 minutes behind the English time. In vast countries, it has been found convenient to fix time zones or belts, all places in each zone keeping the same time. As each zone is 15 degree wide, its time is exactly one hour ahead of its western and one hour behind its eastern neighbour. Thus in Canada there are five Time Zones, called Atlantic, Eastern, Central, Mountain, and Pacific, whose times are respectively four, five, six, seven, and eight hours behind Greenwich time. Similar arrangements exist in the United States and Australia. In fact, in nearly all civilised countries the standard time now adopted is either Greenwich time or differs from it by an exact number of hours or half-hours.

Indian Standard Time

Formerly the Indian standard time was the Madras local time, which was 5 hours 21 minutes and 10 seconds in advance of Greenwich time. But as this standard time did not bear a simple and easily remembered relation to Greenwich time, it has been changed since 1st January 1906 from Madras time to that of a place lying on 82½° E longitude, so as to make the Indian standard time exactly 5½ hours ahead of Greenwich time. This place roughly corresponds with Allahabad whose local time is 5 hours and 28 minutes, or only two minutes short of the standard time. On the 1st January 1906 all the railway and telegraph clocks were put at Standard Indian Time. Calcutta retained its former Calcutta Time which was twenty-four minutes in advance of the Standard Time till 1st September 1947 when it switched over to the Indian Standard Time. But in Bombay the local time was retained only on the clocks that were maintained by the Municipality and in the establishments of orthodox Hindus till 1st September 1949. After these dates the Standard Time became universal throughout India.

How to find the Longitude of a place ?

Just as we can find the local time of a place when its longitude and the Greenwich time are given, we can by the inverse process find the longitude of the place when the local time and the Greenwich time are known. The local time of a place can be found by observing when the sun reaches its greatest altitude there, and the Greenwich time can be obtained by carrying a chronometer set to Greenwich time.

Examples

(1) What is the longitude of a place when it is 5 P.M. at Greenwich and noon at that place ?

The difference of time between the two places is equal to 5 hours or 5×60 or 300 minutes.

For 4 minutes there is a difference of 1 degree of longitude ; for 300 minutes there is a difference of 300/4 or 75 degree of longitude.

As the Greenwich time is ahead of the local time, the place is situated to the west of Greenwich i.e. 75° W.

(2) Find the longitude of a place when the local noon occurs while it is 8.40 A.M. by Greenwich time.

The difference of time is equal to 12—(8-40) or 3 hours 20 minutes, or $3 \times 60 + 20 = 200$ minutes. For 4 minutes there is a difference of 1 degree ; for 200 minutes there is a difference of 200/4 or 50 degrees.

As the Greenwich time is behind the local time, the place is situated 50 degrees E. of Greenwich i.e. 50° E.

Time and Circum-navigation of the Globe

We have just seen that the local time of places according to their position east or west of Greenwich is 4 minutes before or behind Greenwich time for every degree of longitude. Now, if a man travelled eastward round the world and adjusted his watch to the local time, he would set the hands of his watch 4 minutes forward for every line of longitude that he passed, or 1 hour forward for every 15 degrees of longitude, or 24 hours forward for 360 degrees of longitude. Therefore the number of days that he had apparently spent in travelling would be less by 24 hours or one day than the number of days he had actually spent. Thus he would appear to have gained a day. Conversely, if he travelled westward, he would put his watch altogether 24 hours behind Greenwich time, and thus would appear to have lost a day.

On the earliest voyages round the globe, this change of time was not taken into consideration and consequently several strange things happened. When Captain Basil Hall reached Manila (120°E.) he found that the people's Sunday was his Monday. The reason was that he had travelled eastward and gained a day. Similarly, when Sir Francis Drake returned to England after a world voyage he thought that the day was Saturday, whereas it was Sunday. The reason was that he had travelled westward and lost a day. Again at Sitka (135° W.), the old capital of Alaska, where half the people are Russians who had come from Russia across Asia and half are Americans from the United States ; when it is Sunday with the Russians it is Saturday with the Americans, and the Russians are busy on Monday at the very time when the Americans are observing their Sunday.

Date Line

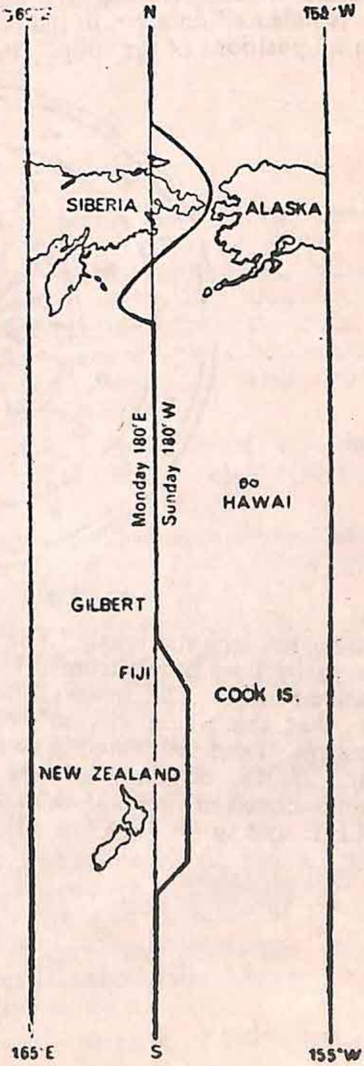


Fig.,12. The Date line

Suppose we travel from Greenwich eastward to a place A on longitude 180 degrees E. We shall find the local time there 12 hours ahead of Greenwich time. So that when it is 6 A.M. on Wednesday April 18th, at Greenwich, it will be 6 P.M. on Wednesday April 18th, at A. Similarly the local time at place B on longitude 180 degrees W will be 12 hours behind that of Greenwich, so that when the time at Greenwich is 6 A.M. on Wednesday April 18th, at **B** it will be 6 P.M. on Tuesday April 17th. Thus two places in longitude 180 degrees E or 180 degrees W agree as regards the time of day, but differ by one day as regards the date. But these two places are in reality one and the same, for if we count from the east, the place will be 180 degrees east, and if we count from the west it will be 180 degrees West.

To avoid this confusion of dates, ships, when they cross the 180° meridian, add or deduct a day according as they are sailing towards the east or towards the west. This line where they change the date is called the Date Line.

Remember that this line does not exactly follow the line of 180° longitude. The reason is that 180° longtitude passes through groups of island in the Pacific Ocean. Had the Date Line followed 180° longitude, it would have caused a difference in date between two neighbouring islands under the same administration. To avoid this confusion of dates, the line has a zig zag course as shown in Fig. 12.

Compass

The compass is an instrument used by seamen, surveyors, and travellers, to indicate direction. The mariner's compass consists of three parts, namely, the box, the card, and the needle. The needle, which is the essential part, is a small bar of magnetized steel. It is balanced on a pin in the box in such a way that it remains level in all positions of the ship. Being magnetized the needle always points towards the north. The circular card is divided into 32 equal parts by lines drawn from the centre to the circumference, these are called Points. The intervals between the points are further divided, so that the whole circumference is finally divided equally into 360 degrees. The four principal points are called the Cardinal Points: viz., North, South, East and West. The names of the rest are compounded of these, as N.E., S.E., S.W., N.W., N.N.E., N.N.W., N.E.E. and so on (See Fig. 13)

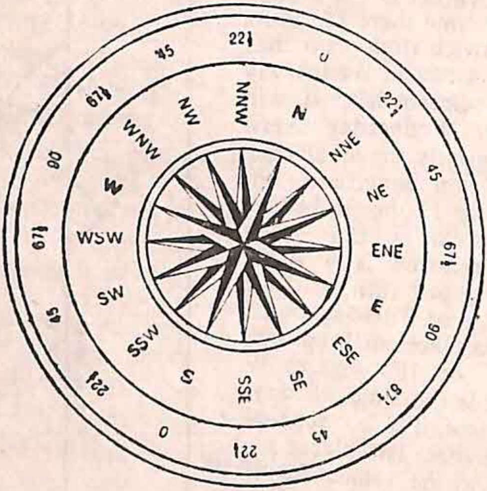


Fig. 13. The Compass

16

Representation of The Earth-Projection

The Globe :

Owing to its nearly spherical form the earth can best be represented by means of a globe. On a terrestrial globe are marked the chief features of the earth, viz., the continents, islands, oceans, countries, lakes principal rivers, mountains, etc., to show their relative size, situation, and distance. Similarly the lines of latitude and longitude, the equator, the Tropics of Cancer and Capricorn, and the Arctic and Antarctic Circles are also shown. The ordinary structure of such a globe is as follows :

1. A metallic rod passes through the centre of the artificial sphere. This rod represents the axis of the earth upon which it rotates from west to east in 24 hours.

2. The sphere is placed upon a stand in such a way that the inclination of the rod is the same as that of the axis of the earth which is inclined at an angle 66½° to the plane of its orbit.

3. A metallic circle surrounds the sphere, which is attached at the extremities of the axis. As all parts of the sphere, when it is rotated, pass under this circle, it serves as a general meridian, called the brass meridian. Degrees of latitude are marked on it.

4. The framework in which the globe is suspended is a circular wooden band. It divides the sphere into northern and southern hemispheres. As it represents the horizon, it is called the wooden horizon.

5. An hour-circle with a movable point or index, which runs round the axis of the sphere, is attached to the north Pole. It is divided into 24 equal parts, which represent the hours of the day.

6. To measure the distance of places and find their relative position a quadrant of altitude or movable place of brass, divided into degrees, is screwed on the brass meridian.

7. The mariner's compass, which we have already described, is fixed under the sphere.

The Map

Though the globe is an exact representation of the earth on a small scale, it is not large enough to show the details of the features of the earth. If it were made of very large size, it would be very expensive and inconvenient to handle. Therefore some more convenient form of representation is necessary. Such a form is the map. But maps are flat and the earth's surface is curved. A flat surface cannot coincide with or lie evenly on a curved surface. Take a sheet of paper and try to fit it on the surface of a sphere. The two surfaces cannot coincide unless the paper is crumpled at several places. To overcome the difficulty, different methods are employed according to the purpose of the map and the size of the area to be respresented, but all are based on the principle described below.

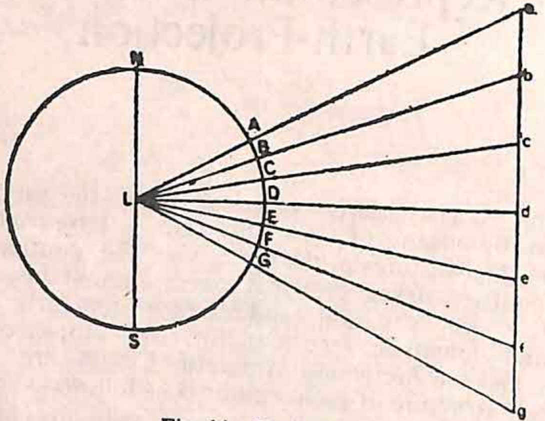


Fig. 14. Projection.

Projection

In figure 14 NS is a hollow glass globe with A, B, C, D, E, F and G, seven trees painted in black upon it. L is the position of a lamp placed at the centre of the globe. A screen is put at some distance from the globe. As soon as the lamp is lit, the light will throw the shadow of the black trees on the screen. This throwing forward or projecting the features of the gold on to the flat surface of the screen is called Projection.

Kinds of Projection

Note in the last figure that the distances AB, BC, CD, DE, EF, FG, on the globe are all equal, but the they are not so on the screen. They become greater as they get farther away from the centre. The rays LN and LS are parallel to the screen and therefore will not fall on it. Hence with the light in this position, it is impossible to produce a map of a complete hemisphere. As already stated, different methods of projection are used according to the purpose of the map and the area to be represented. The most important projections are the following :

1. Stereographic Projection

In this projection, the light is supposed to be placed at the position L on the surface of the globe as shown in Fig. 14. The distances from A to G on the Globe are all equal. The corresponding distances *a* to *g* on the screen gradually increase from the centre outwards. Therefore the parallels of latitude and the meridians, which are equidistant on the globe, become farther apart from one another on the map as they get away from the centre. Moreover, the parallels of latitude remain no longer parallel to one another as they are on the globe, but get curved as they reach the poles. Hence the map constructed by this method will show the central portions correctly, the outer parts will be distorted in the shape and enlarged in area. The map of the polar regions, which are the central portions of a hemisphere, is made by this method.

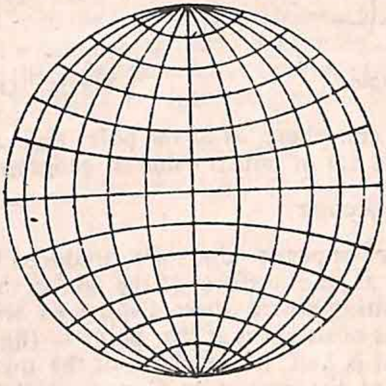
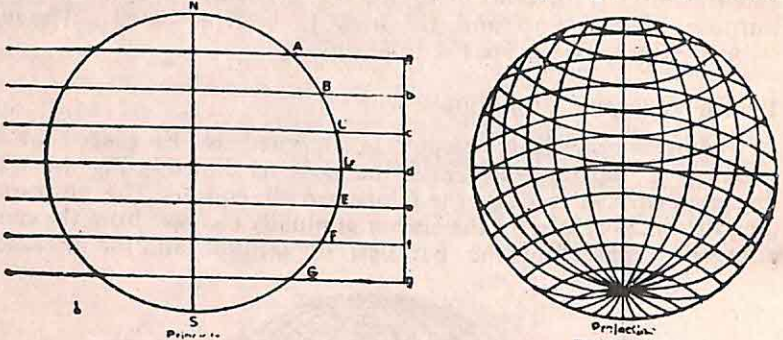


Fig. 15. Stereographic Projection

2. Orthographic Projection

In this projection, the light is supposed to be placed at an infinite distance from the globe. All the rays of light will now be parallel as shown in figure 16. The distances A to G on the globe are all equal, while the corresponding distances *a* to *g* on the screen gradually diminish from the centre outwards. Therefore the parallels of latitude and the meridians draw together as they get away from the centre. Again, the parallels of latitude are no longer parallel circles as they are on the globe, but are parallel straight lines. Hence the distortion produced by this projection is just the reverse of that produced by the stereographic projection. This projection, like the stereographic, may be employed in producing maps of the central



Principle

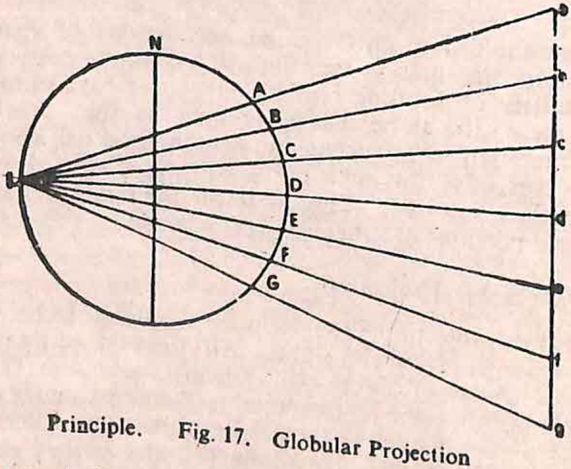
Projection

Fig. 16. Orthographic Projection

portions of the hemisphere, as of the polar regions. Otherwise these two methods are not of much value to geographers.

3. Globular Projection

As distortions of opposite kinds are produced by placing the light at infinity and at the surface of the globe, there must be some intermediate position where these distortions will nearly neutralize each other. This position is at the point L (fig. 17), where LW is half of WN,' that is half of the chord of the quarter-circumference. Observe that equal distances, A to G on the globe, are now projected



Principle. Fig. 17. Globular Projection

as almost equal distances *a* to *g* on the screen. Therefore the parallels of latitude and the meridians are equidistant on a particular line as they are on the globe, but unlike the former, are no longer parallel ; they become curved towards the poles, diverging at the ends. This projection is therfore also known as the Equidistant Projection. Although distances are represented in this projection equally, the map is distorted at the edges and the direction is not shown correctly. This projection is generally used in making maps of the world in hemispheres.

4. Cylindrical Projection

Let us suppose that the screen is wrapped round the globe in the form of a cylinder and touches the globe at the equator. Imagine a light placed at the centre of the globe as shown in fig. 18. The surface features of the globe will be projected on to the inner surface of the cylinder. Unwrap the cylinder and note that the lines of longitude, which on the globe meet at the poles, are parallel straight lines on the sheet. Parallels of latitude, which are circles on the globe and which become shorter as they go towards the poles, are on the screen also straight lines equal in length. Moreover, the distance between them increases very much from the equator outwards, which is not the case on the globe. Therefore, except at the equator, the maps constructed by this projection will represent correctly neither the area nor the shape. But there is one advantage which outweighs these disadvantages. These lines of latitude and longitude are at right-angles to one another, as on the globe. Hence direction will be accurately represented.

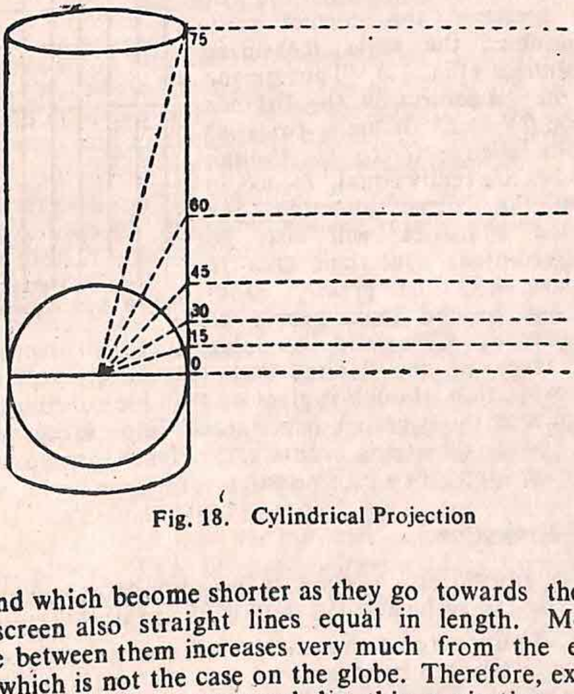


Fig. 18. Cylindrical Projection

5. Mercator's Projection

This projection is based on the cylindrical projection, which was modified in A.D. 1556 by a Flemish mathematician who called himself Mercator. We have seen in the cylindrical projection that the lines of longitude are equidistant straight lines, though in reality they converge at the poles. The parallels of latitude are equal in length and diverge from each other as they approach the poles, though in reality this is not the case. Thus the length of a degree of longitude is represented as being the same in all latitudes. But it is not so. At latitude 60°, it is only half the length of a degree at the equator. In other words, the scale of the map, measuring east and west at latitude 60°, is double the scale at the equator. In order to preserve the correct ratio Mercator doubled the scale measuring north and south. (Fig. 19). Thus on the map made on this projection, the distance from latitude 60° to 61° is made twice as great as from latitude 0° to 1°, though these distances are really equal. Hence, in addition to the correct direction, the shape of the countries will also be correctly represented. But their area in high latitudes will be greatly exaggerated. Thus Iceland looks nearly as large as Berneo, Greenland as large as South America, and Alaska as large as the United State respectively. Nevertheless Mercator's projection, though it gives no true idea of distances and areas (except near the equator), is of special importance to sailors, because it gives directions accurately. Hence seamen always use charts made on Mercator's projection.

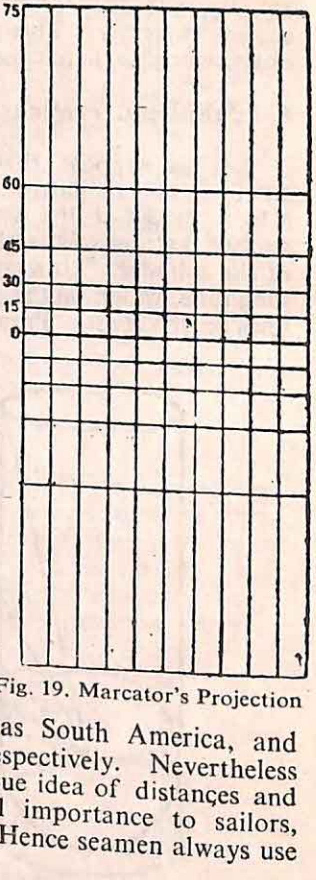
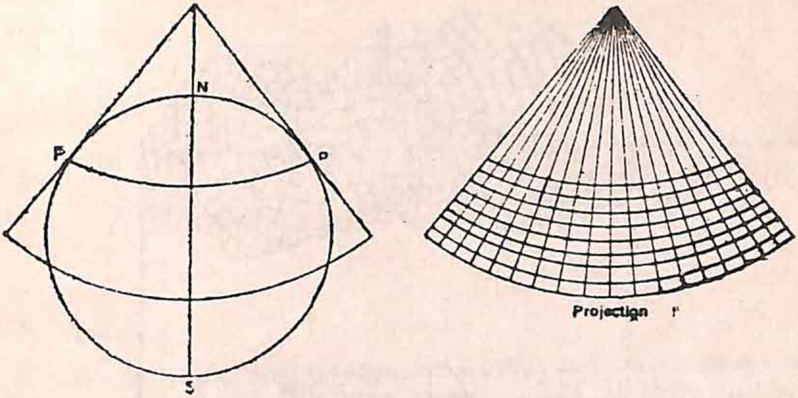


Fig. 19. Marcator's Projection

6. Conical Projection :

In this projection, a cone made of paper is supposed to be wrapped round the globe and the light is placed at the centre.

Its great advantage is that the curved surface of the cone, like that of the cylinder, can be spread out flat without any distortion; this is shown in Figure 20. But, while the cylinder can come in contact with the globe only at the equator, the cone can coincide with it along any line of latitude. If the cone is spread out flat, the parallels of latitude will become parts of concentric circles, that is they will be curved lines parallel to one another and the lines of longitude will become converging straight lines at right-angles to the parallels like Ireland and Denmark. This projection is employed in making maps of separate countries and other relatively small areas.



Principle

Projection

Fig. 20. Conical Projection

Note that in the above examples the general principles of map-making have been illustrated. The globe and the light are not actually used in map-making. Maps are actually made by a method of measurement and mathematical calculation called triangulation, because the basis of all the calculations is the triangle.

How to Represent Elevation on the Map. Land relief, or different elevations of land as mountains, valleys, plains, is represented on the map in two ways :

(1) by contours,

(2) by hachures. (Fig. 21, 22). Contours are lines that join together places of equal elevation. Where the contours spread out, the ground is rather flat, and where they crowd together the ground is steep. Hachures are lines of shading. Where the slope is gentle the shading is light, and where it is steep the shading is heavy. Each method has its advantages. Hachures are much more impressive and the alterations of slope can be beautifully traced, but it is impossible to find from the actual height of the places. Contours on the other hand are less picturesque, but they tell you exactly the height and slope of the places. In some maps, varied shades of colour are also employed to indicated differences of elevation.

Scales

A map is always drawn to a certain scale which shows the relation that any distance on the map bears to the actual distance on the earth's surface. From it we can also determine areas. In using a map we should always know the scale on which it is drawn. This scale is sometimes indicated by a line of certain length, say one inch, which may represent one or more miles. If the scale is one inch to one mile, then one inch on the map will stand for 63,360 inches of actual surface; hence this scale may be denoted by the

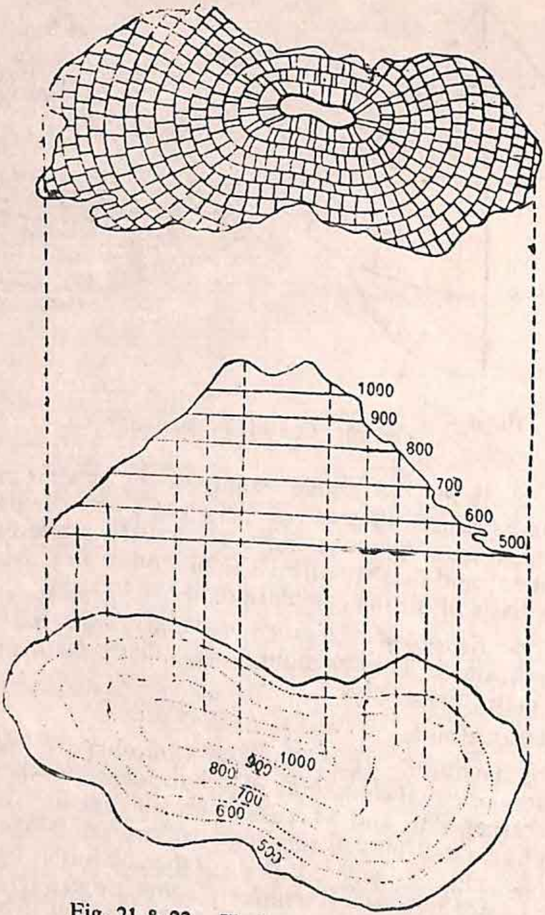


Fig. 21 & 22. Hachures and Contours

representative fraction 1/63,360, or by the proportional figures 1 : 63,360. Such scales are useful when comparing one map with another in the atlas, as maps of the same size may represent very different areas. But they must be used with caution, for we have seen that projection can only give us maps that are true for the middle portion. For large distances and areas, we must bear in mind the kind of projection by which the map is constructed and rely mainly on the meridians and parallels.

17

The Moon and The Eclipses

The Moon

The moon is a moving target which orbits earth in a slightly egg-shaped (elliptical) path that takes it as far as 2,52,710 miles (4,04,306 Kilometres) from earth and as close as 2,11,463 miles (3,38,341 Kilometres) to it. It revolves round the earth in a little more than 27 days. Her mean distance from the earth is about 2,38,856 miles (3,82,170 Kilometres) from the centre of the earth to the centre of the moon. Her mean diameter is about ¼ of that of the earth; surface about 1/13; volume about 1/49 and her mass about 1/81 of those of the earth. The force of gravity at her surface is about 1/6 of that of the earth. Thus, if a man weighing 60 kilogrames is transferred to the moon, he will weigh only 10 kilogrames. For every revolution in her orbit she rotates once her axis, so that the same portion of her surface is constantly turned towards the earth. She is also, like the earth, an opaque body and has no light of her own, but reflects the light of the Sun. A rocket with a speed of 5,000 miles an hour would take 48 hours to reach the moon.

Trip to the Moon

Two American Astronauts, Neil Armstrong (39) and Edwin E. Aldrin Jr. (39) landed in the waterless Sea of Tranquillity of the moon's surface at 01. 48 hours IST on 31st July, 1969; set foot on it at 08.26 hours IST same day and walked on the moon, rather bounced around in the partial weightlessness for 2 hours, 13 minutes and 12 seconds. Having stayed on the moon's surface for 23 hours and 31 minutes, the astronauts began return journey at 23.23 hours. IST on 21st July, 1969 and splashed down in the Pacific Ocean at 22 hours 19 minutes IST on 24th July, 1969 as prearranged. The climatic point of the daring nine days voyage to the moon was when "Eagle" the fragile spidery lunar module of Appollo 11 made a dusty landing with Neil Armstrong and Aldrin, the U.S.A. Astronauts on board. It was the first time a manned space craft had made a landing on the moon's surface. It was the fulfilment of a dream which the countless generations of mankind had dreamt.

The historic moon landing came 11 years, 9 months and 16 days after the space age was inaugurated by the Soviet Union by putting into orbit Sputnik 1, the first artificial Satellite on October 4, 1957. It came 8 years, 3 months and 8 days after Yuri Gagarin orbited the earth on April 12, 1961 to become the first space farer. Neil Armstrong, Edwin E. Aldrin Jr. and Michael Collins began their voyage of glory on Wednesday, the 16th July, 1969, when a huge Saturn-5 hurled them into space. After orbiting the earth for a little over two hours, they fired the third stage on the Saturn which set them on the course to the moon more than 4,00,000 Kilometres away. They reached the vicinity of the moon on Saturday, the 19th July, 1969 and successfully put their Apollo spaceship in the lunar orbit by a rocket burn. The Apollo men left the lunar vicinity and began their journey back to the earth on the night of Tuesday, the 22nd July, 1969 and splashed down in the Pacific on July 24, 1969.

The Americans also launched Apollo 12 on November 14, 1969 and the astronauts landed on the Ocean of Storms. Russia also put into moon's orbit an unmanned spaceship called luna 15. This Soviet craft was moved towards a position where it could take a look at what the Americans were doing. The Soviet craft, however, crashed on the moon 500 miles away from the landing site of the Apollo 11.

Thus the three astronauts went, saw and left foot-prints on the moon dust and brought back valuable rocks and other mementoes for earthly beings to study for more knowledge about their closest neighbour. Their lunar vehicle, "Eagle", the first manned craft to touch down outside the earth, claimed the distinction of being also the first to blast out of a celestial body when it lifted off from the moon at 23.23 hours IST on 21st July, 1969. This one small step for man will mean one giant leap for mankind. The Sea of Tranquillity was seen as a flat surface with small round crators. Small egg shaped stones and boulders were seen strewn all round. The Moon's surface is reported as fine and powdery. The rock strewn and cratored surface of the moon resembles to some desert territory in West America. A sample of rock stolen from the moon appears to be of a fine grain igneous rock with individual mineral grains visible on its surface, said Dr. Elbert King, the curator of the laboratory where the rocks picked up by the Apollo 11 astronauts are being examined. Igneous means a rock hardened from a molten mass. It might have been born in a volcano, or such rock, hardened below the surface, might have been ripped up by a meteorite impact. There is evidence from small strips on the rock that it has been prepared by micrometeorites during its stay on the moon's surface, the scientist said.

Trip to the Mars

The Americans also hurled through space two space crafts on 24th July, 1969 towards the planet Mars. These unmanned rockets, Mariners 6 and 7 were on path which took them within 2,000 miles of Mars. The ships sent back television pictures of the mysterious

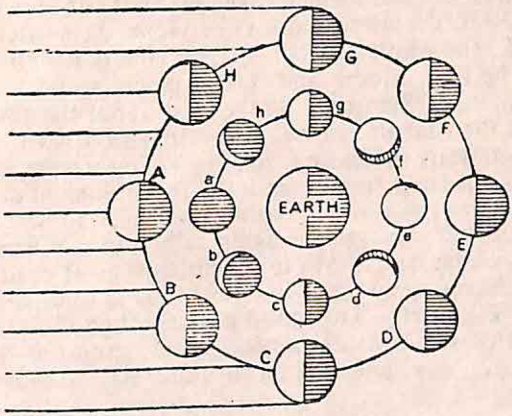


Fig. 23. Phases of the Moon

surface of the planet, that scientists believe, is the likeliest candidate to support life similar to earth. If the pictures confirm that Mars is amenable to life, it may become the target for manned missions in the not too distant future. A scientist in California said that gases detected by Mariner 7 indicated there may be some form of life on Mars. Dr. George Pimantal, incharge of the lower atmosphere experiment aboard Mariner 7, said the two gases detected were methane and ammonia ; which are at the origin of the life evolution on earth. The gases were detected by Mariner 7 over the rim of the Martian South Potan Ice Cap.

The Phases of the Moon

All of us have seen that sometimes the moon appears to a semicircle and finally to a full round figure, which again diminished from night to night till it ends in the new moon. These recurring changes in the appearance of the moon are called the Phases of the Moon.

How the Phases of the Moon occur

The moon revolves round the earth from west to east. Therefore she changes her position with respect to both the earth and the sun. When she comes between the earth and the sun as at position A (Fig 23), her dark half is towards the earth, hence the people of the earth can see no part of her. This position of the moon is called the New Moon. When she moves to position B only, a portion of her bright side appears to the people of the earth, as shown at B in the figure. This is the position of the Crescent Moon. She then appears in the western sky a little before sunset and sets soon after the sun. The crescent grows wider and the time of setting later by about one hour each day. When she comes to position C and G, half of her bright side, or a quarter of the whole surface, is seen from the earth. These positions are called the first quarter and the last quarter respectively. The former takes place about seven days after the new moon, and the latter about twenty-one days after it. When she arrives at E, the whole of her bright side is towards the earth. This is called the Full Moon and takes place about fourteen days after the new moon. She rises in the east about the time of sunset and sets about the time of sunrise. From position A to E her bright portion has been daily increasing in size. Therefore the moon is said to wax between the new moon and the full moon. For the rest of her course, i.e., from portions E to A, she begins to wane or gradually diminish size till she appears again as before. When more than a semi-circle is visible, she is said to be gibbous, as at positions D and F. When less than a semi-circle is visible, she is said to be crescent, as at positions B and H. The moon goes through the above regular phases in a period of about 29½ days. From moon-rise to moon-rise is called a lunar day and the mean lunar day is 24 hours and 54 minutes.

The time of Moon-rise and Moon-set Next Day

Had the moon been stationary, each place on the earth's surface would have come exactly opposite to her after 24 hours and the moon must have risen next day exactly at the same time. But the moon revolves round the earth from west to east, which is the direction of the earth's rotation. While the earth turns once on its axis, the moon moves from position M to M. (Fig. 24), i.e., about 1/27 of her orbit. Hence the earth must turn through the additional angle MOM before the same place A can be opposite to it at A, and the moon will consequently rise for the same place A after 1/27 of 24 hours, or about 54 minutes. Hence the time of rising and setting of the moon gets later each day by 54 minutes, or nearly an hour.

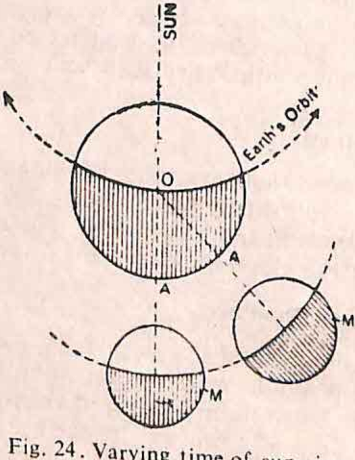


Fig. 24. Varying time of sun-rise

Solar Eclipse

At the time of New moon, i.e., when the Moon comes between the sun and the earth (see. Fig. 25), the light of the sun is obstructed by the moon.

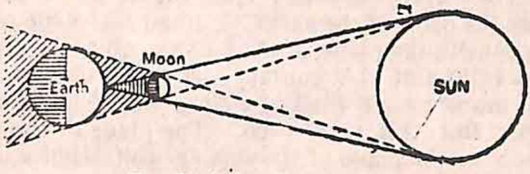


Fig. 25. Solar Fclipse

The people on the earth cannot thus see the sun or any part of it and a solar eclipse is the result. If the sun is entirely hidden, this eclipse is called a total eclipse ; and if it is partly hidden, we have what is known as a partial eclipse. In the figure, the eclipse is total where the dark shadow falls upon the earth, for no part of the sun will be seen. It will be partial where the lighter shadow falls.

Sometimes the moon obstructs the centre of the sun. Then the central portion of the sun's disk is obscured and a bright ring is left round it. Such an eclipse is called an annular or ring-shaped eclipse of the sun. In this eclipse the shadow of the moon does not reach the surface of the earth. (see Fig. 26).

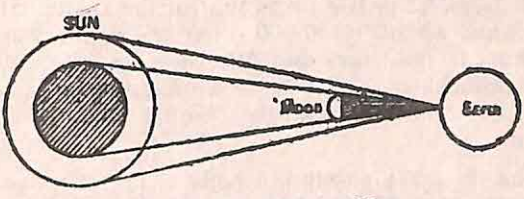
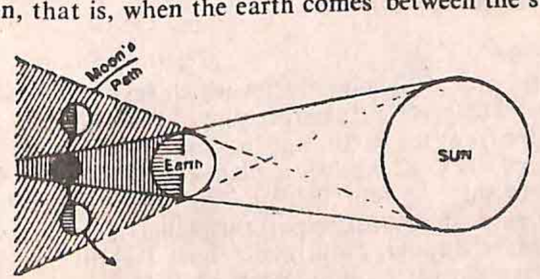


Fig. 26. Annular Eclipse of Sun

Lunar Eclipse : An eclipse of the moon takes place at the time of full moon, that is, when the earth comes between the sun and the moon (see Fig. 27). The shadow of the earth then falls on the moon and a lunar eclipse is the result.



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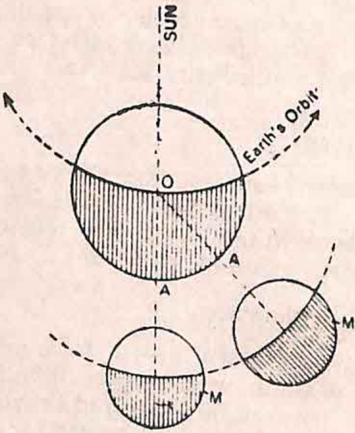

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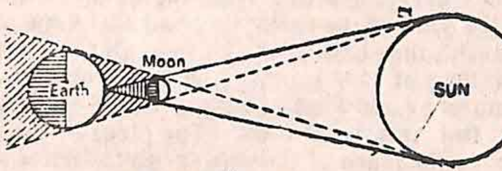

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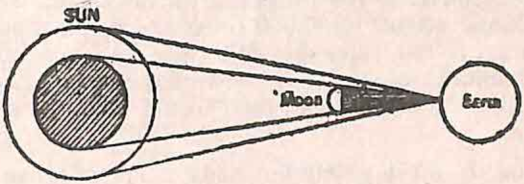

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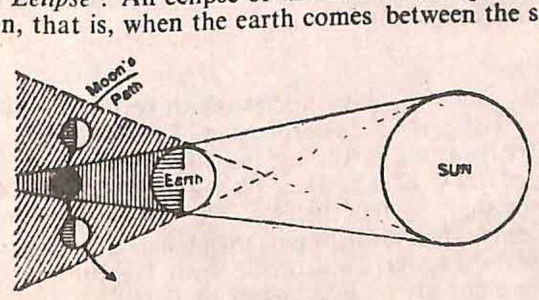

Fig. 27. Lunar Eclipse

Why Eclipses do not occur Every month

We have just seen that the solar eclipse and the lunar eclipse occur at the time of new and full moon respectively. But as the new and full moon take place once a month, how is it that these eclipses do not occur once every month ? Had the moon's orbit been in the same plane as the orbit of the earth, i.e., had the plane of the moon's orbit coincided with the plane of the earth's orbit, there would always have been an eclipse of the sun at new moon and an eclipse of the moon at full moon ; each kind of eclipse would have occurred once every month. But this is not so. The plane of the moon's orbit is inclined at 5° to the plane of the earth's orbit. Hence an eclipse can occur only when the moon comes in the same plane as the earth's orbit, that is, when the sun, the earth, and the moon are in one straight line.

The Solar System

The solar system is the name given to indicate collectively the sun and the group of heavenly bodies which revolve round it as their centre. These heavenly bodies are planets, comets, and meteors.

The Sun

The sun is the central body of the system to which our earth belongs. Its diameter is 109 times that of the earth. It exceeds the earth in volume about 1,300,000 times and in mass about 330,000 times. Its mass is 750 times that of all the planets combined. It is about 93 millions of miles away from the earth; a rocket with a constant speed of 5,000 miles an hour would take nearly 78 days to reach the sun.

The sun is an intensely hot body. The effective temperature of its surface is about 19,000° F. It gives us 7,000 million times the light of the brightest star and in a year sufficient heat to melt a layer of the ice 27.4 meters thick spread over the surface of the earth. But we get only a small fraction of the total heat radiated. If the sun were covered with ice 15.2 metres deep, the heat emitted would melt this in one minute.

Planets

Planets are heavenly bodies which revolve round the sun as their centre. The earth is therefore one of the planets. The planets look like stars from the earth, but they differ from stars in two respects; first, they change their places while the stars do not ; and secondly, they shine by reflected sun-light while the stars shine by their own light. The most important planets are : Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto of which we have already read in chapter 1.

Satellites

A satellite is a secondary or smaller planet which revolves round a larger one. The moon is a satellite of the earth. Neptune is accompanied by one satellite, Mars by two, Uranus by four; Jupiter and Saturn each by nine.

Comets

Comets are heavenly bodies which appear like stars accompanied by a train of light which is sometimes short, sometimes extending over half the sky. They revolve round the sun, not in a circular path, but in a long ellipse.. They are, therefore, carried to such distances that they sometimes disappear for several generations. They seem to shine mainly by their own light, but part of their brightness is borrowed from the sun.

Meteors

Meteors are transient bright bodies seen in the atmosphere. These bodies shoot rapidly across the sky and then disappear. Hence they are also called shooting or falling stars. They are believed to be due to the existence of a great number of extremely minute bodies revolving round the sun; when these bodies happen to enter the earth's atmosphere they are heated by friction and become luminous.

Milky Way

The Milky Way, or the Galaxy, is the long white luminous track which is seen at night stretching across the sky from horizon to horizon. The bright track or belt is due to the existence of a multitude of stars so distant and so blended as to be distinguishable only by the most powerful telescopes.

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18

Land and Agents of Land Configuration

The Crust of the Earth and its Temperature

Scientists say that the earth was originally a nebula or glowing mass of intensely hot material revolving round the sun, of which it had formed a part. Subsequently its outer surface gradually cooled, condensed and hardened. Even now the earth is very slowly losing its heat, while the sun is still in a glowing condition. This hardened surface of the earth is called its Crust. The crust is only 20 to 40 miles thick, or only 1/400 to 1/200 of the total diameter of the earth. The interior of the earth is still very hot. This is evident from the existence of volcanoes, which throw out molten matter, from geysers or springs of hot boiling water, and from the uniform rise of temperature in mines. On an average the temperature in a mine increases one degree F. for every 60 feet. Thus at a depth of a mile, the temperature is about 100° higher than that on the surface layer, and at a depth of 30 miles is high enough to melt any rock. But in spite of its very high temperature the interior of the earth is more or less solid. This is due to the great pressure of the rocks of the crust, for the increased pressure raises the melting points of solids.

Rocks and their Formation

The various substances of which the earth's crust is composed are called rocks. This term applies equally to the hardest stone and to the softest sand. Rocks are divided into three main classes :

(a) Igneous.

(b) Sedementary.

(c) Metamorphic.

(a) *Igneous Rocks* are those rocks which have been formed by the action of fire (Latin ignis, fire). They were originally in a molten state in the interior of the earth, but have subsequently cooled down and solidified. When they have solidified at great depths below the surface of the earth under great pressure they are called Plutonic or Intrusive e.g. Granite (from Pluto, the king of the infernal regions). When they are thrown out in a molten state by volcanoes and cooled at the surface they are called Volcanic or Extrusive as lava, basalt. The Intrusive igneous rocks are generally shapeless and crystalline in character. Extrusive or volcanic rocks show no crystallization. They are smooth and glossy. As Igneous are not formed in layers or, strata they are also called unstratified rocks. They are found in India in the Raj Mahal Hills and the Deccan.

(*b*) *Sedementary rocks* are those rocks which have been formed by the action of water (Latin aqua, water) Large quantities of igneous and other rocks are gradually worn away by the action of rain and rivers and deposited in layers in the beds of seas and lakes. Under pressure, this mud or sediment is cemented together and forms a solid mass. As these rocks are found in layers or strata, they are called stratified rocks, and as they are formed by the sediment brought down by rivers, they are also called sedimentary rocks. Sandstone is an example.

It sometimes happens that remains of plants or animals, such as leaves, branches, bones, teeth and shells, become buried in a sediment as it is being laid down. These remains are known as fossils. They are of value in deciding the age and mode of formation of the rock. Sometimes, these remains of plants, animals and other organisms occur in large quantities, decay, and harden under pressure into strata of rocks. Such rocks are then called organically-formed rocks. Chalk, limestone, coal and coral are examples. There is a third group of acqeous rocks known as chemically formed rocks ; Rock-salt and gypsum are examples. These are nothing but redeposited, precipitated material.

(*c*) *Metamorphic Rocks* are those rocks which have been changed from their original form by heat or pressure. They are generally hard and crystalline in appearance. Gneiss (altered granite), marble (altered limestone), slate (altered clay), anthracite (altered coal) and quartzite (altered sandstone) are examples. In some cases, the changes have been so great that it is difficult to discover the original composition of the rock. These rocks are compact, hard, resistant to erosion and crystallized.

Agents of change. The changes which continually take place on the surface of the earth are chiefly due to two causes :

(a) Internal heat, which causes movement of elevation or upheaval, and subsidence or depression of the earth's crust.

(b) External agents, which include rain, rivers, wind, frost, waves, glaciers, etc.

Internal Heat and the Formation of Mountains and Valleys. As the interior of the earth is hotter than its exterior, heat must travel from the former to the latter. As soon as it reaches the surface, it escapes into space. This process is called terrestrial radiation, and the interior of the earth is always losing its heat by this process.

As the interior of the earth gradually cools and contracts, the outer crust has to occupy a smaller space. The result is that the crust falls into wrinkles or folds (see Fig. 28)

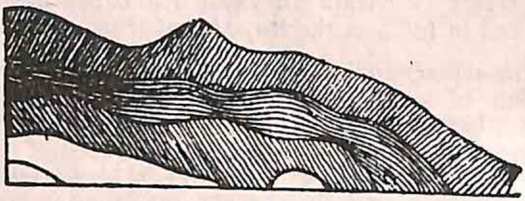

Fig. 28. Folding of Earth's Crust

The raised parts are mountains and the depressed parts are valleys. Such mountains are called Mountains of Elevation or Folded Mountain. The Himalayas, the Atlas Mountains, the Alps, the Andes, and the Rocky Mountains are examples. At first sight it may seem strange that long and lofty ranges such as these should have been formed by the contracting of the earth and the wrinkling of its crust. But we must remember that the diameter of the earth is about 8,000 miles, while its highest mountain (Everest) is only about 5½ miles above sea level, that is, about 1/1450 of this diameter. If the earth were represented by an apple three inches across, then the height of Mount Everest above sea-level would be shown by 1/500 of an inch, a space which would be quite imperceptible to the naked eye. The Fold Mountains are also found by the foundation of wrinkles on earth's crust due to the drifting of continents.

There is another kind of mountain which is the result, not of elevation, but of "weathering," i.e., wearing down of the surface by weather, wind, rain, etc. volcanoes throw up a large amount of molten matter from the interior of the earth. In course of time the softer parts wear away, while the harder parts remain standing out from the general level. Such mountains are called Residual Mountains and regions formed in this way are known as disected Plateaus. The Highlands of Scotland and of Scandinavia are typical examples of such mountains and plateaus. There is another type of mountains called "*Block Mountains*". When earth movement leaves a block of higher land standing between two areas of low land the higland is called "block mountain" or "horse" or mountain of denudation.

Sometimes the rocks are very rigid and hard, and when the earth's crust wrinkles, these rocks, instead of folding, crack and the strata then slip down on one side. Such cracks are called *Faults* (Fig. 29).

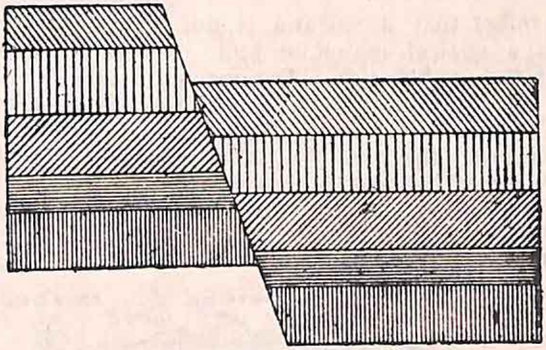

Fig 29. Rock Faults

Sometimes the strata slips down between two or more less parallel faults as shown in Fig. 30. The depression caused in this way is known as a *rift-valley*. The Jordon and the Dead Sea, the Red Sea, Lake Nyasa, Lake Tanganyika, and the central plain of Scotland are all rift-valleys. Sometimes, on the other hand, a portion of the crust is left standing between two or more faults, while the surrounding country subsides. This crust is called a *Crust-block*. The island of Sicily is an example.

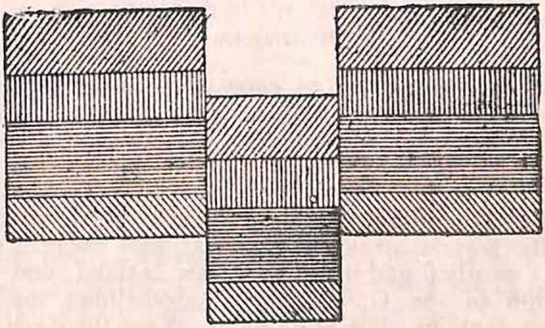

Fig. 30. Rift Vally

Volcanoes

During the crumpling and winkling of the earth's crust, it sometimes happens that a deep opening is made. Water then passes through it, comes into contact with the highly heated rocks of the interior of the earth, and produces such a large quantity of vapour and steam that molten matter is forced up through the opening to the surface and is piled round it. A conical mountain formed in this way is called a volcano.

Remember that a volcano is not a burning mountain. A volcano is a conical mountain built of material thrown out from openings in the earth's crust. The opening is called the neck of the volcano. The cup-like hollow at the top of the neck is called the crater. The molten matter which is forced up the volcano is called lava. Volcanoes that are in active operation are called *Active Volcanoes* ; those that operate not continually but at intervals of several years, are called Dormant or *Latent Volcanoes* ; while those that have entirely ceased to act are known as *Extinct Volcanoes*, (See Fig. 31).

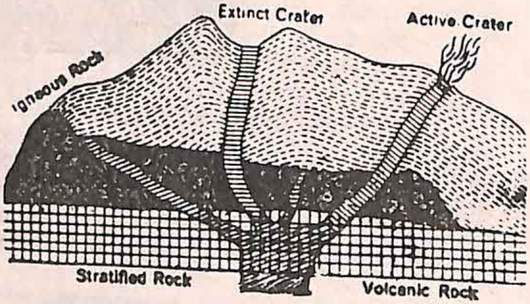

Fig. 31. Diagram of Volcano

Geysers are springs of hot water which is thrown up, sometimes with dense clouds of steam and to great height. Like volcanoes they are caused by the production of steam and vapour in the interior of the earth and are subject to intermittent eruptions. The high temperature of this water is due to its passing through the heated walls of the rocks, which are subjected to volcanic influences. Occasionally geysers show themselves as mere pools of warm water. Geysers are mostly found in Iceland, New Zealand, and the Yellowstone Region of the United States. Sometimes, the hot water of these geysers contains silica in solution. When the water evaporates, this mineral is deposited round the spring. This dry deposit is called *Sinter* ; it has a bright half-transparent appearance. The famous pink and white terraces occurring in New Zealand and the Yellowstone Park district of the Rocky Mountains are formed of this sinter.

Earthquakes

An earthquarke is a sudden shaking or heaving of the earth's crust, generally accompanied by a deep rumbling noise. This shaking may be a slight tremor or a violent convulsion. Earthquakes are believed to be due to the following causes :—

(a) When the interior of the earth cools and contracts, the crust cracks and a shaking is felt.

(b) Sometimes strata of rocks actually slip down along faults already formed.

(c) When water finds its way to the heated rocks of the interior, so much steam is produced underground that it expands and forces its way to the surface, and upheavals and tremblings take place.

Though earthquake shocks are felt more or less in all parts of the world, they are most common and most violent in volcanic districts and regions of folded mountains. They often accompany volcanic eruptions and cause heavy damage to life and property. In violent earthquakes, the openings made in the ground are so extensive that entire cities and islands may be swallowed up. The earthquake wave which is produced by the sudden rush of the retreating sea upon the land is perhaps as destructive as the earthquake itself. Yet earthquakes may be constructive as well as destructive. They may bring upwards near the surface rocks containing useful minerals, and they may throw up new land for human habitation.

Rising and Sinking Coasts

Besides, the sudden changes caused on the surface of the earth by volcanoes and earthquakes, a slow movement due to the gradual loss of heat and contraction of the earth, is always going on. Some parts of the earth are rising while others are sinking. The coasts of North America (California, British Columbia), Eastern India, Northern China and Japan are rising. The east coast of the United States, both sides of the English Channel, and the east coast of Australia are examples of sinking coasts.

Formation of Islands

Owing to the shrinking of the earth, sometimes a strip of land is separated from the continent by the subsidence of the intervening area into the ocean. Such strips of land are called Continental Islands. As they were once a part of the mainland, they are similar to the continent in geological structure, vegetation, and animals. Moreover, the water between the islands and the continent is shallow. The British Isles, Madagascar, New Zealand, and the Andamans are examples of such formation. Another kind of islands is known as Oceanic Islands. They are usually far from the continent and rise suddenly out of deep water owing to the upheaval of the earth. On account of their remoteness, they are different from the mainland in geological structure, flora and fauna. Australia is the typical example. Oceanic islands also include a kind of island which is formed by tiny sea creatures called *Coral Polyps*. Such islands are therefore called Coral Islands. These creatures secrete the carbonate of lime which is dissolved in the sea-water and deposit it around their bodies to form a skeleton. In course of time this deposit of carbonate of lime accumulates, and comes to the surface of the water by the action of the waves. A chain of such islands is called a *Reef. If a* reef is near the shore, it is called a *Fringing Reef*. If at a greater distance, it is called a *Barrier Reef*, and if it has a ring-like appearance surrounding a lagoon of shallow water, it is called an *Atoll*.

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External Agents of Change

Denudation

In the last chapter we have read how the internal heat of the earth, by producing movements of elevation and subsidence of the crust, brings about changes on the surface of the earth. In this chapter we shall study how changes are caused by the external forces acting on the earth's surface. The main forces are :

(a) Rain,
(b) Rivers,
(c) Ice,
(d) Frost,
(e) Wind,
(f) Heat and
(g) Sea.

These are always gradually breaking the rocks, wearing away the softer parts, and carrying and depositing these at other places. This process of wearing away the surface of the earth and laying it bare is called Erosion or Denudation. Let us consider the action of each agent separately.

(a) **Action of Rain**

Rain acts upon the surface of the earth in three ways :

(i) By heating upon the earth's surface it loosens parts of it and washes them away. This is mechanical weathering.

(ii) *Carbonation*—Rain falling through the atmosphere dissolves an appreciable quantity of Carbon Dioxide, and becomes a dilute solution of carbonic acid which has a marked effect upon Rocks like limestone and chalk.

(iii) *Oxidation*—Rainwater contains 'free' oxygen which is particularly effective on rocks containing iron compounds.

(iv) *Hydration*—Some Rocks when they come in contact with hydrogen in rain water form Hydrates Eg : Gypsum.

(v) *Solution*—Some rocks disintegrate by simple solution—Eg: Gypsum and Rock salt.

This causes the water, when it falls upon the rocks, to dissolve some of their constituents, such as carbonate of lime, and to form hollows and channels in them. Chalk, limestone, and marble are forms of carbonate of lime and are easily acted on by rainwater.

Stalactites and Stalagmites

When water, which has carbonate of lime dissolved in it, percolates through the roof of an underground cave, each drop of water as it hangs on the roof partly evaporates and some carbonate of lime called calcite is left as a thin crust upon the roof. This gradually accumulates in the shape of hanging columns from the roof. These columns of limestones hanging from the roof of the cave are called Stalactites. The rest of the lime contained in the drops of water is deposited on the floor of the cave and in course of time forms into pillars which are called Stalagmites.

Formation of Springs and Wells

All the rain-water that falls on the earth is disposed of in three ways:

(i) a part flows away into streams and rivers;
(ii) a part is evaporated by the heat of the sun;
(iii) the residue, of which there is a large quantity, goes underground.

The rocks which allow water to pass through them are called permeable or pervious rocks, such as limestone, chalk, sandstone. The rocks which do not allow water to pass through them are called impermeable or impervious rocks, such as clay, granite, etc. It is not necessary that permeable rocks should be soft rocks. Sandstone and limestone are hard enough for building purposes and yet water can pass through them. On the contrary, a layer of clay is comparatively soft and yet it does not allow water to go through it.

If a permeable rock lies upon a thick layer of impermeable

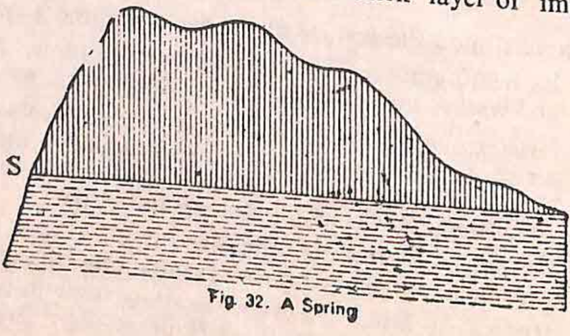

Fig. 32. A Spring

rock, water will pass through the former but will be unable to penetrate the latter. Therefore it will accumulate and begin to flow above and along the impermeable rock until its own pressure forces the water out on the hillside at a point where the two rocks meet (see the point S in Fig. 32). Such an outflow of water is called a Spring.

Springs may be *Perennial or Intermittent*, according as they flow throughout the year or during a part of it. When the permeable rock lies upon the impermeable rock in an inclined way as shown in Fig. 33, the water will cease to flow at S when the level of water falls below the line SW. Such a spring is called an Intermittent Spring.

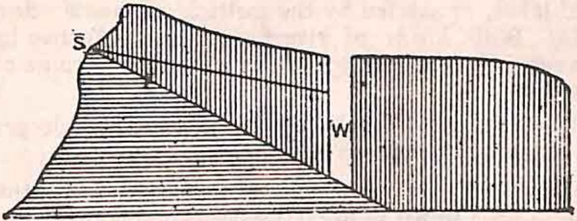

Fig. 33. An Intermittent Spring and a Well

If a sufficiently deep hole is made through permeable rock it will fill with water and will form a Well.

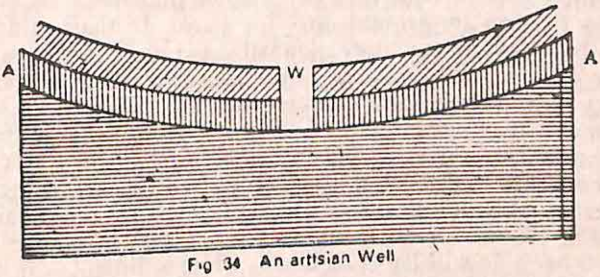

Fig 34 An artsian Well

Artesian Wells

If a layer of permeable rock lies between two layers of impermeable rocks with both of its ends open as shown in Fig. 34, the rain water will pass through the ends A and A′ and saturate the permeable rock to the permeable rock, water will be forced by pressure. A well of this kind is called an Artesian Well. Such wells have been sunk in Quetta (West Pakistan), Ludhiana, Queensland, South Australia, and various parts of the Sahara, where barren desert has thereby been changed into smiling gardens. The conditions necessary for the formation of artesian wells are (1) The rocks should be synclinal or dip. (2) There should be a payer of permeable rock on top. (3) There should be a copious rainfall to give sufficient supply of ground water.

(b) Action of Rivers

Rain-water which has not evaporated and does not go to under-ground, flows into streamlets which combine and form rivers. Such rivers do not run throughout the year. They become dry in the dry season. Rivers that take their supplies of water from springs and lakes, or are fed by the melting of snow, flow all the year round. Both kinds of rivers are most effective in bringing about changes on the surface of the earth. They cause changes in three ways :—

(i) They eat into their beds and banks, thus deepening and widening themselves and forming valleys.

(ii) They carry the material thus separated from their banks and beds down to lower levels.

(iii) They deposit in their lower courses almost all the mud, silt, sediment, and other waste material, and form fresh land.

Thus rivers are the great levellers of land and if there were no forces to counteract them, they would in course of time, reduce the earth's surface to one uniform level. Being swift, they are purely destructive in the upper part of their course, called the *Mountain Stage*. Here, their chief effect is to wear away their banks and deepen their beds. Thus they bring down numerous rock-fragments which by friction are ground into fine sand. In their middle course, called the *Plain Stage*, they deposit as much as they wear away. As their speed slackens, every obstacle turns their course aside, so that they tend to form into curves which are called *Meanders*. When the river is straight, the current is swift along the middle of the channel, and the slowest along the banks, so that deposits will occur along the banks and erosion in the middle. But when the course is meandering or winding, the current is swiftest on the outside of the curves and slowest on the inside of the curves. Therefore, the bank on this outer-side will be worn away, while sediment will be deposited on the inner side of curves. Such new soil formed by deposits brought down by the river is known as *Alluvium*. Alluvial soil is very fertile. The whole of the Gangetic plain is made of this soil and hence its extraordinary richness.

Formation of a Delta

In the lower part of its course, called the Delta Stage, the river deposits more than it wears away, so that here its chief work is construction. Its speed is very slow and it deposits all the mud and sediment which it has brought down. When it reaches the sea, this mud falls to the bottom. If there were no tides, the mud would accumulate till in course of time it rises above the water level. The river then forces its way to the sea across this barrier through several branches called Distributaries. The triangular land thus

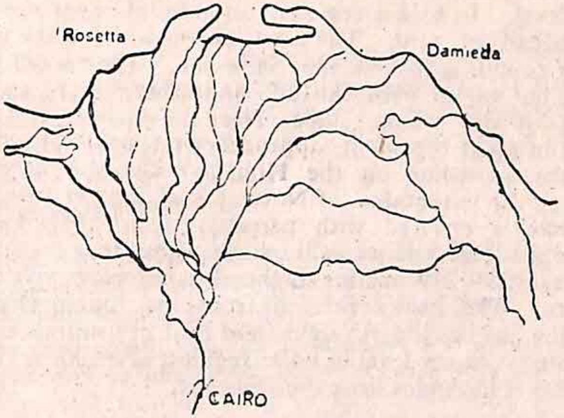

Fig. 35. Delta of the Nile

formed at the mouth of the river is called a Delta. Delta (△) is a letter of the Greek alphabet and this name was applied by the Greeks to the delta of the river Nile from its triangular shape. (See Fig. 35).

Estuary

If the river falls into a sea where tides occur, it forms no delta because the tides will not allow the mud and silt to accumulate there. No sooner is the mud deposited than it is washed away into the sea. Thus the mouth of the river will be kept wide and open. Such a wide-open mouth is called an *Estuary*. Rivers having estuaries are very useful for navigation, and flourishing ports are established on them, because ships can readily shelter from storms and other sea dangers. The Ganges forms a delta, while the Thames and the Amazon form estuaries.

Basin or Drainage Area

The whole area from which water drains into a river is called its Drainage Area or its Basin. It consists of not only the valley of the main river but also the valleys of all the rivulets and streams, with all their tributaries, that run into it. The ridge which divides one river-basin from another is called the Water-parting. An area the water of which runs into hollows and lakes that have no outlet is called the area of Inland Drainage ; the Plateau of Seistan is an example.

(c) **Action of Ice**

Ice is frozen water and is, like running water, a powerful agent of change. Its action is seen in polar regions and among lofty mountains.

Snow-line

The temperature of the atmosphere decreases as we ascend above sea-level. In higher regions, on account of intense cold there is snow instead of rain. The limit above which snow never melts all the year round is called the *Snow-line*. The snow line is not a fixed limit, but varies with latitude and other factors, such as rainfall, moist or dry winds, slope. Near the equator, it is at a great height, but in polar regions it approaches the sea-level. The lowest height of the snow-line on the Himalayas is about 4876.8 metres, while that on the mountains of Norway is about 152.4 metres. The Arctic Circle is covered with perpetual snow and the snow-line reaches the sea-level. It is well to remember that the snow-line of the Himalayas is 1219 metres higher on the northern side than on the southern. The heavy rainfall from the Indian Ocean lowers the snow-line, while the drought and heat of Central Asia raise it. The snow line is at sea level in polar regions, at 6500 ft in pyrenes and at 18000 ft in Andes near the equartor.

Glaciers and their Formation

The snow that falls on the mountains above the snow-line accumulates. The upper layers compress the lower ones, which are thereby changed to half-snow and half-ice. Such a substance is called *neve* or fields of snow. Moreover, the snow at the surface melts during the day and forms water, which passes through the lower layers and during the night freezes them together. Thus gradually a compact mass of ice is formed. The force of gravity from below and the pressure from above cause the whole mass to slide down the valley like a river of ice. This slow-moving river of ice descending a mountain valley is called a *Glacier*. As the Glacier moves down the valley, stones and pieces of rocks fall upon it. This material collects and forms two long heaps at the sides of the glacier. These heaps are called *lateral moraines*.

When two glaciers unit, the two lateral moraines form into a *central or medial moraine*. The material heaped at the foot of glacier is called a *terminal moraine*. Similarly, pieces of rock fall into cracks of ice and are carried along the bottom of the glacier, they are called *ground moraine*. The glacier, together with its moraines, grinds into pieces even the hardest rocks over which it passes and thus scores out hollows and valleys. Such valleys are called *glaciated valleys*. Many of the valleys of the Himalayas and the Alps have been formed in this way. Thus we see that ice in the form of glaciers is a powerful agent of change.

When a glacier reaches a warm latitude it begins to melt and gives rise to rivers. The Ganges and the Jumna owe their rise to the Himalayan glaciers. In polar regions the glaciers reach the sea and break off into huge masses, which remain floating. These huge masses of ice floating in the sea are called icebergs. Icebergs are very dangerous to ships; ships striking against them are broken into pieces. The Titanic was wrecked in this way in 1912 on its maiden voyage.

(d) Action of Frost

Frost is the state of the atmosphere in which water freezes. When water or water-vapour freezes, it expands. Crevices of rocks contain air and along with it the vapour of the atmosphere. On cold nights this vapour becomes frozen, and on freezing it expands and may break the rocks into pieces.

(e) Action of Wind

Wind is an important agent of change in deserts and sandy areas. Winds carry sand from one place and heap it up at other places in the form of long low ridges called *sand-dunes*.

Winds bring about change in another way also. In the form of sand-blasts they strike against the rocks and wear away the softer parts.

(f) Action of Heat

During the daytime, rocks are heated and expand. At night they radiate heat and become cold and therefore contract. This alternate expansion and contraction causes rock to break up gradually. It is in this way that rocks in deserts are reduced to sand.

(g) Action of the Sea

The sea is never still ; there are always waves and current in it. As the waves beat against the coasts, they wear away the softer parts and make bays and bights. The harder parts remain as projecting headlands and capes. The softer parts are worn away and deposited by the sea at other parts of the shores ; thus extensions of the coast line take place. Again the constant friction of water against the base of cliffs detaches their summits and in this way wavecut platforms are formed.

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The Ocean and its Currents

Sea-water and its Saltness. Rivers falling into the ocean bring, dissolved in their waters, such substances as sodium chloride (common salt), carbonate of lime, potassium and silica. A large quantity of the last three is used up by marine animals in order to form their shell and skeletons. The common salt, which is not so used, is left behind and makes the water salty. This saltness differs in degree in different parts of the ocean. Those parts where the evaporation is greater and the supply of fresh water less, are salter than those where the conditions are reversed. Thus the Mediterranean and the Red Seas are much salter than the Baltic and the Black Seas. Again, owing to the constant supply of fresh water by rainfall and rivers, the surface water of the ocean is less saline than its deep water. The average salinity is 3.5 lbs of salt to 100 lbs of water.

Its temperature. Just as all parts of the ocean are not equally salty, so they are not uniform in the degree of temperature. Near the equator the temperature of the surface water is the highest (about 77 degrees F.) and gradually decreases as we approach the poles, where it is 28 degrees F. Again, closed seas have a higher and more uniform temperature than open seas. Though the surface temperature varies greatly, it has been found that at very great depths the ocean keeps everywhere an almost uniform temperature. Compared with the land, the ocean has a more equable temperature. The reason is that water becomes heated very slowly, and when ocean heated cools very slowly. On the other hand, land is heated rapidly and also cools quickly.

Movements of the Ocean. The chief movements that take place in the ocean are :

(a) waves,

(b) currents,

(c) tides.

Waves. Waves are mere ridges or undulations on the surface of water. They are produced by winds and sometimes by the trembling of the earth on account of earthquakes. It should be remembered that in waves there is no forward movement of water. The particles of water merely rise and fall, and at last return to the position from which water is shaken at one end but does not change its place. That there is no forward movement of water in waves will be evident if we place on the surface of a wave a small piece of wood ; it will toss up and down but will not be carried forward. When large waves approach a shore or shallow place, their lower part is checked and the upper part falls forward with great force ; such broken waves, topped with white foam or surf, are called breakers. A gentle wave is called a ripple, which is a mere ruffling of the surface of the water.

Currents. A current is a flow of water in the ocean from one part to another, it is like a river in the sea. Currents may be at a great depth or at the surface. Those that are at the surface and are produced by the prevailing wind are called drifts. Remember that currents are named after the directions to which they flow. An easterly current is one which flows towards the east. On the contrary, winds are named after the direction from which they blow. A west wind means a wind blowing from the west.

The existence, force and directions of currents have been found out in various ways. A common method is to note the direction taken by floating objects. The sealed bottles, containing information of the place and date of their despatch, may be sent adrift ; they may be carried long distances before they are picked up and their message read. Sir James Clark Ross, who explored the Antarctic seas, sent afloat a number of such bottles in 1842 near Port Phillip in Australia. Before wireless telegraphy was invented, news of shipwrecks occurring in the heart of the ocean often reached other parts of the world in this way. It is clear, therefore, that the waters of the ocean may travel forward over immense distances.

Humboldt, the great explorer, calculated that a drop of water in the Gulf Stream would return in about two years and ten months to the place from which it originally started. A boat, without being propelled by wind or artificial means, would drift by the force of the current from Florida to Newfoundland in about fifty days.

Causes of Currents. Currents are produced or modified by the following factors, acting singly or together.

(1) *Unequal Temperature.* The rays of the sun are more nearly vertical near the equator than near the poles. Therefore water in the equatorial regions is warmer than that in the polar regions. This warm water flows towards the, poles as a surface current, and to take its place the cold water of the poles flows south as an undercurrent.

(2) *Unequal Density.* As the water in the polar seas freezes to ice, the remaining water becomes salter and consequently heavier. This heavier water sinks down and flows as a deep-water current, and to keep up the equilibrium, warmer water from the equatorial regions comes in as a surface current.

(3) *Unequal Evaporation.* We have already read that in regions where the evaporation is greater or the supply of fresh water less, a current flows in from other places to make up the deficiency of water thus caused. Thus the Mediterranean Sea, which is wide and is situated near the Sahara and has, therefore, active evaporation from its surface, receives currents from the Atlantic and the Black Seas. On the other hand the Baltic Sea sends out a current, because evaporation is small and the supply of fresh water large.

(4) *Prevailing Winds.* If winds blow constantly in one direction, they carry the surface water in the same direction. Thus the prevailing winds are a great force in producing surface currents or drifts. In the region of the trade-winds, which blow from north-east and south-east, the ocean currents flow towards the west. In the region of the anti-trade winds or "Westerlies" the currents flow towards the east.

(5) *Rotation of the Earth.* Though the rotation of the earth is not directly the cause of currents, it modifies their directions and splits them up into branches. This happens in the following way. The earth rotates from west to east, and has greater velocity at the equator than at a places north or south of it. Therefore currents coming towards the equator from the northern hemisphere are turned towards their right, while those from the south are turned towards their left. This law was first discovered by a scientist named Ferrel and is known as Ferrel's Law. Thus the North Equatorial Drift in the Pacific Ocean turns to its right as the Japan Current and the South Equatorial Drift turns to its left as the South Australian Current.

(6) *Configuration of the Land.* The wedge-like projection of the coast of Brazil checks the warm North Equatorial and the South Equatorial Drifts and the sends former towards the north as the Gulf Stream, and the latter towards the south as the Brazilian Current. But for this interruption, the North Drift would have flowed straight on and there would have been no Gulf Stream.

Kinds of Currents Currents are of three kinds, viz.,

(1) Constant.

(2) Periodical,

(3) Local.

Constant currents are those which flow in the same direction throughout the year, as the Gulf Stream. Periodical currents are those which flow for a certain period in one direction and for the rest of the year in another. They change their direction as the direction of the winds which produce them is changed. Thus the north-east and the south-west monsoons produce periodical currents in the Indian Ocean. Local currents take place in enclosed seas, as the current of the Mediterranean Sea. Of the three, the constant currents are the most improtant. Let us study them separately.

Currents of the Atlantic Ocean

(*1*) *West Wind or South Atlantic* Drift is a cold current flowing from Cape Horn to the Cape of Good Hope. As it is under the influence of the "Westerlies", it is called the West Wind Drift, and as it is near the Antarctic Ocean, it is also named the Antarctic Drift.

(*2*) *South Atlantic or Benguela Current* is a cold current flowing from the Cape of Good Hope to Cape Frio on the west coast of South Africa. It is thus a continuation of the West Wind Drift.

(*3*) *South Equatorial Drift*. Starting from where the Benguela Current ends this current flows, under the influence of the trade-winds and the rotation of the earth, along the equator as a warm drift. At Cape St. Roque on the coast of Brazil it is divided into two branches. One branch goes towards the south and the other branch goes to the north. This drift is about 4,000 miles long and 450 miles broad at the point of division. Its average temperature is about 75° F.

(4) *The Brazilian Current* is the south branch of the South Equatorial Drift and is a warm current. It flows along the coast of Brazil up to Buenos Aires, where it turns towards the east and joins the West Wind Drift a little south of the Cape of Good Hope.

(*5*) *Gulf Stream*. The north branch of the South Equatorial Drift, after parting from the Brazilian Current at Cape St. Roque, enters the Caribbean Sea, passes round Cuba, and issues from the Gulf of Mexico as the famous Gulf Stream. Here it is a deep wide current of dark-blue warm water flowing at the rate of about four miles an hour. Its temperature is 80° F. or 9° above that of the ocean in the same latitude. Near Florida, it is joined by the North Equatorial Drift. At first it flows parallel to the coast and gradually becomes wider, shallower and cooler. Near the southern coast of Newfoundland it turns towards the north-east under the influence of the south-westerly winds. It then disappears as a definite current and becomes the North Atlantic Drift. When about half-way across the Atlantic, it is divided into two branches. One goes towards the south off the coast of Portugal. The other goes straight on, passes along the western shores of the British Isles, and then flows along the coast of Norway. It is owing to this warm current and its influence upon the winds flowing over it that England enjoys a mild climate and the harbours of Norway remain open throughout the year, while those of Greenland in the same latitude are closed due to ice. Of all the Atlantic currents the Gulf Stream is the most important.

(6) *North Equatorial Drift* is a surface current of warm water flowing along the north of the Equator, just as the south Equatorial Drift flows along the south of the equator. As already stated, it joins the Gulf Stream near Florida.

(*7*) *Canaries Current* is a branch of Gulf Stream Drift. After flowing by the shores of Portugal and north-western Africa, it joins the North Equatorial Drift and thus completes the great round. The still water covered with floating sea-weed and other grasses lying within this whirl is called the Sargasso Sea.

(8) *Guinea Current, or the equatorial Counter-current* is the result of surplus water heaped up by the North and South Equatorial Drifts near the north-east coast of South America.

(9) *Arctic Current* is a cold current and flows along the east coast of Greenland. It joins the Labrador Current.

(10) *Labrador Current* is also a cold current, flowing along the east coast of North America and meets the Gulf Stream coming from the south. As a result of the meeting of these cold and warm currents fogs are produced.

Currents of the Pacific Ocean

(1) *West Wind or South Pacific Drift* is a cold current which flows from the Antarctic Ocean toward the western coast of South America.

(2) *Humboldt or Peruvian Current* is a cold current which flows northward along the west coast of South America. It corresponds exactly to the Benguela Current which flows along the west coast of South Africa. The result is that in both the continents the west coasts are much cooler than the east coasts.

(3) *South Equatorial Drift* is a continuation of the Peruvian Current. Being near the equator and under the influence of the trade-winds it flows towards Australia as a drift of warm water. Near the east coast of New Guinea it is divided, as in the Atlantic Ocean, into two branches, one going to the south and the other to the north.

(4) *East Australian or New South Wales Current* is the south Equatorial Drift and flows along the east coast of Australia as a warm current. It corresponds to the Brazilian Current.

(5) *Kuro Siwo or Japan Current*. The north branch of the South Equatorial Drift, after parting from the East Australian Current, flows northwards to the east coast of Japan as a current of warm water under the name of Kuro Siwo or Japan Current. From Japan onwards it comes under the influence of the "Westerlies", changes into a drift, and touches British Columbia on the west coast of North America. This current exactly corresponds to the Gulf Stream, both in its course and in its effect.

(6) *North Equatorial Drift* is a surface current of warm water flowing from Mexico along the north of the equator to the East Indies. It joins the Kuro Siwo near the Philippines.

(7) *Californian Current* is a branch of the Kuro Siwo Drift. It flows southward along the coast of California and rejoins the north Equatorial current.

(8) *Equatorial Counter-current* is similar to the current of the

same name in the Atlantic Ocean and is the result of the same cause.

(9) *Kurile Current* is a current of cold water which flows southwards through Bering's Strait, and the channels of the Kurile Islands, when it takes its name.

(10) *Alaska Currents*—It is the northern branch of North Pacific Drift.

Currents of the Indian Ocean

(1) *West Australian Current* is a cold current. It is a part of the Antarctic Drift and flows northwards along the west coast of Australia. It corresponds exactly to the Benguela and Humboldt currents.

(2) *South Equatorial Drift* is a current of water flowing from Australia to Madagascar along the south of equator. It corresponds to the drifts of the same name in the Atlantic and Pacific Oceans. Near Madagascar, it is divided into two branches, one going to the south and the other to the north.

(3) *Mozambique Current* is the southern branch of the South Equatorial Drift. Passing through the Mozambique Channel, it flows along the east coast of South Africa where it is known as the Agulhaus Current. Then under the influence of the westerly winds it rejoins the West Australian Current.

(4) *Periodical Currents.* North of the equator, the currents of the Indian Ocean are determined by the south-west and north-east monsoon, and are therefore periodical currents. They are known as the North-east and South-west Monsoon Drifts respectively.

(5) *Indian Counter Current*

From the above description of the various currents in the three great oceans it is clear that they are all parts of the vast oceanic circulation of the globe, and must be studied in relation to one another.

Influence of Currents on Climate and Commerce

(1) By their continuous motion, currents help to keep the water of the ocean pure and fresh.

(2) The temperature of places is raised or lowered according as they are situated near warm or cold currents. Labrador and the British Isles lie almost in the same latitude ; yet the former remains frozen for most of the year on account of the cold Labrador Current, while the latter enjoy a mild and equable climate throughout the year on account of the warm Gulf Stream Drift.

(3) Warm air can contain more water-vapour than cold air. Therefore winds which come in touch with warm currents are laden with water vapour and give abundant rainfall to the places where they blow. Thus Japan, which is under the influence of the warm

Kuro Siwo, gets more rainfall than Kamchatka Islands, which are under the influence of the cold Kurile Current.

(4) When warm and cold currents meet, fogs are the result. Thus the climate of Newfoundland, where the cold Labrador Current meets the warm Gulf Stream is foggy.

(5) Warm currents keep harbours free from ice and thus trade can be carried on there throughout the year. But for the warm Gulf Stream the harbours of Norway would remain closed for a large part of the year.

(6) Currents help ships sailing in the direction of their flow, and shipmasters choose their course accordingly. Thus ships going from England to Australia cross the Atlantic Ocean a little south of Rio de Janeiro so that they may take advantage of the force of the Brazilian Current which joins the Antarctic Drift near the Cape of Good Hope.

(7) The most important food-fish (cod, herring, etc.) live in cold water and are brought by cold currents to warmer regions as to the shores of Newfoundland, Japan, and South Africa.

(8) Currents also help to keep alive those animals and organisms which live at great depths. Oxygen is as necessary to life in the ocean as on land. Currents, by moving and circulating the water of the ocean, carry oxygen from the surface to the lower depths. Had there been no vertical movement of the water the oxygen at great depths would soon have been exhausted and all deep-sea organisms would have perished.

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21

The Tides

What Tides are ?

Tides are the gradual rise and fall of the waters of the ocean at definite intervals in regular succession. The rise of the water is called the *flow* of the tide, and the fall of the water is called the *ebb* of the tide. The sea rises or flows for about six hours, and then the fall or ebb begins and continues for six hours more. Again the flow and the ebb return as before, so that in about 25 hours the rise and fall each occur twice. Remember that in the tides, as in the waves, there is no advance of the water itself, but like the undulations of a flag the water rises and falls. Unlike currents and waves, tides affect the whole ocean from the surface down to the lowest depth, whereas an ordinary wind-wave is unable to displace the smallest grain of sand at a depth of 1,200 feet or 365.8 metres.

How Tides are Caused ?

All bodies attract one another with a force which is directly proportional to the product of their masses and inversely proportional to the square of their distances. Thus the greater the quantity of matter in a body, the stronger is its attraction ; and the greater its distance, the less is its pulling force. This force is known as *gravitation*. According to this force of gravitation both the moon and the sun are exerting their attraction on the solid earth, as well as on the water which surrounds it. But the moon's attraction is much greater than that of the sun. The reason as stated before is that, although the sun is of much greater mass, its distance from the earth is very much greater than that of the moon. The sun's mass is nearly 27,000,000 times the moon's mass, and the sun's distance is about 390 times the moon's distance. Consequently, in the formation of the tides the sun's force is to the moon's force in the proportion of about 5 to 11 ; the moon is therefore the principal cause of the tides.

In Fig. 36 E is the centre of the earth, which is enclosed all round by water represented by T.L , T′,L′. Now the moon is exerting her attraction simultaneously at T, L, T′, L′. But because T is water which can move freely, unlike the earth, and is nearer to the moon than E, the attraction of the moon is greater at T than at E.

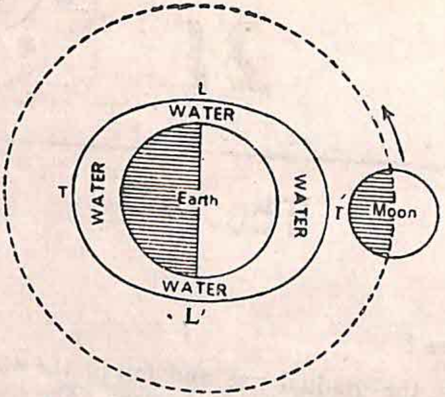

Fig 36. How Tides are caused

Therefore the water at T, not being rigidly connected with the earth, is drawn out and produces a high tide. Again, E is nearer to the moon than T ; hence the centre of the earth is attracted more strongly than the water at T′ which, not being rigidly connected, is left there as high water. Thus two high tides occur at the opposite sides T and T′ simultaneously. At L and L′ will occur two low tides at the same time, because some of their water will flow to T and T′.

Had the earth been stationary with respect to the sun and the moon, the tides would also have been stationary. But as the earth turns upon its axis, every place is brought directly opposite the attracting force. Thus the rising of the water becomes a great tidal wave or flow which travels round the globe, each place on the sea having a rise and fall of water at an interval about six hours.

Time of the Corresponding High Tide Next Day

The time of the high tide depends on the time of moon-rise and moon-set, which has already been explained in Chapter IV. It will be useful to restate the argument. Had one of the two, the earth or the moon, been stationary, each place on the earth would have come exactly opposite to the moon after 24 hours, and the corresponding high tide next day would have occurred after exactly 24 hours. But the moon revolves round the earth from west to east which is the direction of the earth's rotation. While the earth turns on its axis the moon moves from the position M to M′ (see Fig 37), i.e., about 1/27 of her orbit. Hence the earth must turn through the additional angle MEM′ before the same place. A will be opposite to it at A′. The time taken by the earth in turning through this additional angle will be 1/27 of 24 hours or about 54 minutes. Hence the corresponding high tide next day occurs not after 24 hours but after 24 hours and 54 minutes, or appoximately after 25 hours.

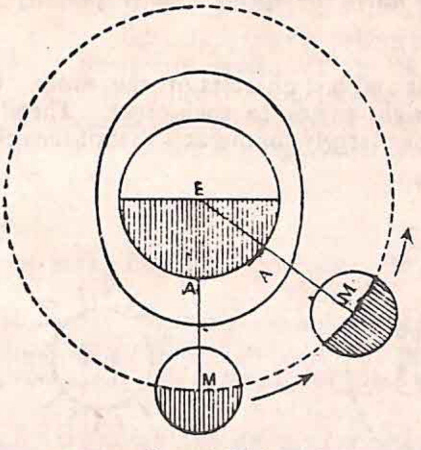

Fig. 37. Why time of High Tide Varies ?

Spring Tides

We have read that the sun also exercises an attractive power on the earth and its waters, although the power of the moon is greater on account of her nearness. At new moon and full moon, the sun and the moon are in line with the earth and therefore they exert a joint influence. Consequently, the high tides produced are higher than usual and the corresponding low tides lower. Such high tides are called *Spring Tides*. They occur at intervals of a fortnight. (see Fig. 38).

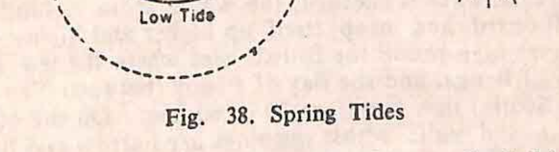

Fig. 38. Spring Tides

The Spring Tides do not usually occur exactly at the time of new moon or full moon, but after an interval. Thus, at London, the Spring Tide occurs two and a half days after new or full moon, and the Neap Tide is similarly delayed. This interval is called the *Age of the Tide*. The height of the Spring and Neap Tides varies with the changing distance of the moon from the Earth ; when the Moon is nearest to the Earth the Spring Tide is specially high.

Neap Tides—

At the first and last quarters of the moon, the sun and the moon are at right-angles to each other. Therefore the attraction exerted by the one largely counteracts that of the other. Consequently the tides produced are lower than usual. Such low tides are called *Neap Tides*. They also occur twice in a month. (See Fig. 39).

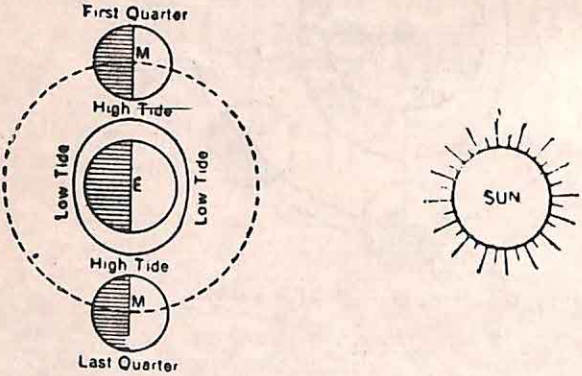

Fig. 39. Neap Tides

Height and Speed of the Tides

The height and the speed of the tides depend upon the depth of the ocean and the configuration of the land. In the central part of the ocean the tides scarcely rise beyond two or three feet, but in shallow seas and gulfs and gradually narrowing and shallowing channels they rise very high. The reason is that, while the lower part of the tidal wave is checked, the water from behind continues to pour forward and heap itself up higher and higher. Thus the tides rise very high round the British Isles where the sea is shallow. In the Bay of Bengal and the Bay of Fundy (between New Brunswick and Nova Scotia) they rise from 20 to 60 feet. On the other hand, inland seas and gulfs whose openings are narrow and lie obliquely to the course of the tidal wave are almost tideless, such as the Mediterranean and the Baltic seas. The difference between average high and low wave is called the *Range of the Tides*. At New York it is about 6 feet and at London Docks about 19 feet.

When tides directly meet funnel-shaped estuaries, that is mouths of rivers which become gradually narrow and shallow as they go inland, there occurs a violent uprush of water. This high wall of water, caused by the conflict between the river current and the tidal wave rushing violently up the river, is called a *Bore*. Bores occur in the river Tsien-Tang (30 feet high), the Hoogli (25 feet), the Amazon (13 feet), the Garonne (12 feet), and the Severn (9 feet).

The velocity of the tides is greatest where the ocean is the freest and the deepest. In the free depths of the Southern Ocean this velocity is about 1,000 miles per hour, while in restricted seas like the North Sea the speed is hardly one-twentieth of that amount. The lines which join places having the high-water mark at the same time are called *Co-tidal Lines.*

Importance of Tides

The tides are of great importance to man for the following reasons :

(1) By carrying away from the mouths of the rivers the slit and mud brought down by them, they prevent the waterways from being blocked up and thereby render rivers navigable that would not otherwise be so.

(2) By increasing the depth of water near coasts at the time of their flow, they enable ships to enter ports where they would otherwise have been obliged to remain outside. They thus help trade by enabling seaports to be built in sheltered position easily reached on the land side as well as by sea.

(3) By keeping the ocean in constant motion and mixing the salt-water of the sea with the fresh water of the rivers, they prevent its water from freezing and from stagnating.

(4) By carrying away into the heart of the ocean the refuse and rubbish brought down by rivers they act as scavengers and thus improve the sanitation of the places situated on or near the sea. The public health in countless cities, towns, and villages owes much to the cleansing action of the tides.

22

The Atmosphere and its Circulation

Composition of the Atmosphere

The atmosphere is the gaseous covering which completely surrounds the earth. It extends to a great height, about 200 miles, but grows less and less dense with elevation. It consists mainly of one-fifth of oxygen and four-fifth of nitrogen. Besides these two gases, it contains a small quantity of carbonic acid gas and a certain amount of water-vapour. This last-mentioned constituent, i.e, water-vapour, is very important from the geographical point of view.

Moisture of the Atmosphere

The water of oceans, rivers and lakes is always being turned into invisible vapour by the heat of the sun. This process of turning water into vapour is called *Evaporation*. As vapour is lighter than air, it is carried by winds and spreads through the atmosphere. The amount of water-vapour which the air can hold depends upon its temperature. Warm air can hold more of it than cool air. At a particular temperature, when the air cannot hold any more vapour, the air is said to be saturated.

When the saturated air comes into contact with a cold body, its temperature is lowered. As it cannot then hold all the vapour it held previously, some of the vapour condenses and becomes visible in various forms, such as dew, hoar-frost, fog, mist, rain, snow, and hail. This process whereby vapour becomes visible and takes a liquid form is called *Condensation*.

Dew

Evaporation is caused by the heat of the sun acting on the surface of water. Therefore the hotter the day is, the more active is the evaporation, and consequently the greater is the amount of water-vapour present in the atmosphere. At night the earth and all objects on it radiate or lose their heat, some more, some less. The air also grows cooler and cannot hold all the vapour it contained in the day-time. Some of the vapour is consequently deposited in the form of little drops of water on grass and other objects which are good radiators. These droplets of water are called *dew*. When the temperature falls below zero (the freezing point) the drops of dew are frozen. This frozen dew is called *Frost*. When the water-vapour freezes before it is formed into dew, it forms into *Hoar-frost*. As radiation is necessary for the formation of dew, there is no dew in shady places or during cloudy nights.

Fog

In addition to oxygen, nitrogen, carbonic acid gas, and water-vapour, the atmosphere also contains moles or small particles of dust. The presence of these dust particles will be evident if ray of light is admitted into a room through a small hole. These particles of dust play a great part in the formation of fog and clouds. When the water vapour condenses on those particles which remain floating in the air near the surface of the earth, the result is called *Fog*. When the vapour is condensed at a greater height, it is called a *cloud*. Mist is the same as fog, except that it contains larger particles of moisture.

Rain

Clouds, which are nothing but tiny particles of water floating at a great height, being lighter than air, are carried hither and thither by the winds. When they reach a cooler area or come in contact with some cold surface, further condensation takes place. The drops of moisture then become so heavy that they cannot be borne by the air and so they fall as rain. They do not always reach the surface of the earth, for while falling they sometimes pass through a layer of dry unsaturated air and are wholly evaporated. If the temperature of the air is below freezing-point, drops of moisture freeze and fall as snow.

Rain-gauge

The rainfall of a place is measured by an instrument called a

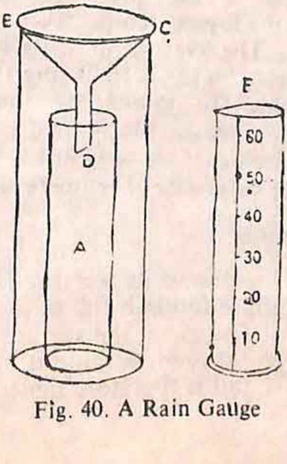

Fig. 40. A Rain Gauge

Rain-gauge. It consists of two parts :

(a) a collecting can, and

(b) a measuring glass.

The collecting can A is placed in an upright-cylinder, open at the top and containing a funnel BCD which drains into the can below. Any rain which falls over the mouth of cylinder runs down into the can and is there collected. At fixed intervals, the water is emptied out and the amount measured in the graduated glass E. (See Fig. 40). Though the rainfall is measured in inches, India has recently adopted millimetre as the unit for measuring rainfall.

When we say that the Mean Annual Rainfall of place is so many inches we mean that, if all the rain that falls upon that particular place during a normal year be collected without the least amount being lost by evaporation or flowing away, the amount of water would cover the area to the depth of number of inches indicated. Lines on a map joining places having the same mean rainfall, monthly or yearly, are called *Isohyets* (Greek isos, equal; hyetos, rain).

Temperature of the Atmosphere

The atmosphere is not heated by the rays of the sun directly. If the air is dry it allows the rays to pass through it to the earth without absorbing any of their heat. Thus the surface of the earth is first heated and then the layer of air which touches the earth's surface is heated. Then the heat passes to the layers lying next to the heated air, and so on until the whole atmosphere is heated. Thus, higher the layer is, the colder it will be; this is why, the mountains are colder than plains. On the other hand, if the air contains water-vapour, it absorbs some of the heat of the sun's rays when they pass through it and so it becomes warm. This is how clouds are dispersed by the sun and the sky becomes clear.

The temperature of the atmosphere is measured by an instrument called a Thermometer. Thermometers are of many kinds, but the mercury thermometer is the most common. The difference between the highest and the lowest temperature of a place is called its Range of Temperature. The average of these readings is called its Mean Temperature. Places on the map having the same mean temperature, monthly or annual, are joined by lines called Isotherms (Greek isos, equal ; therm, heat). Maps are drawn showing isotherms for January or July because these months, being the coldest and hottest show the greatest extremes of temperature.

Pressure of the Temperature

The pressure of air is due to its weight. That it has weight can be proved by first weighing a football full of air, and again when the air has been taken out. The air at the surface of the earth is much denser than that at a high latitude, because it has to bear all the weight of the air above it and is therefore under great pressure. The atmospheric pressure at the surface of the sea is 15 lbs. on each square inch. It varies with heat, height, and the amount of water-vapour present in the air. The atmospheric pressure is halved at exactly, 18,000,00 ft. The greater the heat, the less is the pressure. As water-vapour is lighter than air, the presence of water-vapour in the air reduces the atmospheric pressure.

Barometer

The atmospheric pressure is measured by an instrument called a *Barometer* (Greek baros, weight; metron, measure). This instrument consists of a glass tube well over 30 inches in length. It is closed at one end and open at the other. It is filled with mercury and then inverted in a dish of the same liquid. It will be found that the column of mercury in the tube falls to a height of about 30 inches. The reason is that the pressure of the air on the mercury in the dish is sufficient to support a column of mercury about 30 inches high in the tube, so long as there is a vacuum above this column.

Places having the same mean atmospheric pressure are joined by lines on the map. Such lines are called Isobars (Compare them with isotherms and isohyets)..

Distribution of Pressure

The distribution of atmospheric pressure on the surface of the earth is not uniform, but permanent differences of pressure exist on different parts of the earth. The sun is vertical over the equator twice during the year, i.e., on March 21st and September 23rd, and almost slashing during the rest of the year. Thus near the equator, the heat is the greatest and the pressure the lowest. The region of great heat and low pressure is called the *Equatorial Belt of Calms* or the *Doldrums*, and extends approximately between 9 degrees N. and 1 degree S. There are two other belts of low pressure, one lying between 50 and 60 degrees N., and the other, roughly, along the Antarctic Circle or 60 degrees S. . They are due to the rotation of the earth. As the earth rotates, the atmosphere also rotates with it in the northern hemisphere round the North Pole and in the southern hemisphere round the South Pole. One result is that the air tends to whirl away from the poles and to heap up towards the equator, just like water in a basin when it is stirred with a stick. This whirling away of the air from the polar regions leaves less air approximately between latitudes 50 degrees and 65 degrees both north and south of the equator, and thus causes those areas of low pressure.

In addition to these three belts of low pressure, there are two belts of high pressure. They lie roughly along latitudes 35 degrees N. and 30 degrees S. and are respectively known as Calms of Cancer and Calms of Capricorn. The heated air of the hot equatorial belt of low pressure rises high, reaching the upper regions of the atmosphere it becomes cool and heavy and blows towards the poles, getting lower and lower at the same time. At latitudes 35 degrees N. and

30 degrees S, it meets the conflicting current of air coming from the poles towards the equator, with result that the air is heaped up

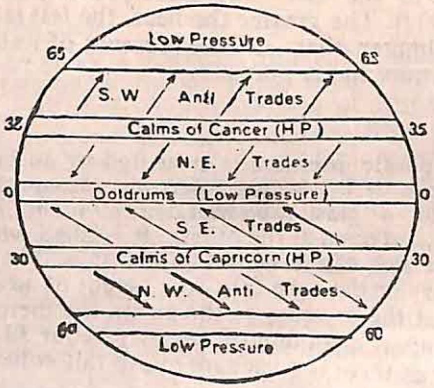

Fig. 41. Distribution of Pressure and Permanent Winds

there. These latitudes consequently become areas of high pressure. (See Fig. 41).

Movement of the Atmosphere

Air in motion is called *Wind*. Winds are caused by the difference of atmospheric pressure at various places on the surface of the earth. They blow from areas of high pressure to those of low pressure. The air coming in contact with a heated surface is also heated. This heated air expands, becoming less dense or lighter. Thus an area of low pressure is created, and the lighter air rises. To take its place the air from regions of high pressure flows in. This also in its turn is warmed, expands, becomes lighter, and rises. Thus a current of air flowing from one part of the earth's surface to another, or a wind is produced.

Kinds of Winds

Winds, like currents are of three kinds, viz., permanent, periodical, and variable. Permanent winds are caused by permanent differences of pressure; periodical winds are caused by differences of pressure at definite intervals ; and variable winds are caused by differences of pressure resulting from local peculiarities and special conditions.

(1) Trade-Winds and Anti-Trade Winds, How they are caused ?

From the distribution of pressure on the surface of the earth given above, it is clear that in both the northern and the southern hemispheres a belt of high pressure lies between two belts of low pressure. As winds blow from areas of high pressure to those of low pressure, so from each of these two belts of high pressure two sets of winds will blow to those of low pressure, one towards the equator and the other towards the poles. The winds that blow towards the equator are called *Trade-winds*, while those that blow in the opposite direction towards the poles are called *Anti-trade-winds*, or simply *Anti-trades*.

Their Direction

If the earth were stationary, these trade-winds would have blown from due north to due south in the northern hemisphere, and from due south to due north in the southern hemisphere. But the earth rotates from west to east with much greater velocity at the equator than at the poles. These winds coming as they do from latitude 35 degrees N. and 30 degrees S. towards the equator, that is, from places having less velocity to those having greater velocity, are, according to Ferrel's Law (already explained) left behind and become north-east and south-east winds, according as they are north or south of the equator.

Similarly, the anti-trade winds which blow polewards, i.e., from places having greater velocity to those having less velocity, gain on the earth's rotation and become south-west and north-west, according as they are in the northern or the southern hemisphere. As their direction is westwards, they are also called "Westerlies".

Their Range

·The limits of latitude within which these winds blow are not fixed, but follow the course of the sun. As the sun goes above the equator towards the Tropic of Cancer, these limits shift further towards the north pole in the northern hemisphere and towards the equator in the southern hemisphere, and *vice versa* as the sun goes below the equator towards the Tropic of Capricorn. On an average, the trade-winds blow between 35 and 9 degrees N. and also between 30 degrees and 1 degree S. while the anti-trades blow between 35 and 65 degrees N. and also between 30 and 60 degrees.

Some Notable Conclusions

(1) As the trade-winds blow from the north-east and the south east they first strike the eastern side of the countries to which they blow. Therefore whatever moisture they bring with them is given to the eastern side. Thus within the tropics, the eastern portions are rainy, while the western portions are dry. Rajputana, Arabia, the Sahara, the California Desert in the northern hemisphere, and the West Australian Plateau, the Kalahari Desert, Peru, and Northern Chile in the southern hemisphere, are all dry places because they are situated on the western side. On the other hand, East China, Indo-China, Thailand, Malaya, Laos, Cambodia, North and South Vietnam, Abyssinia, the south east coast of the United States, the east coast of Central America, the north-east coast of South America in the northern hemisphere, and eastern Australia, Natal, and

eastern Brazil in the southern hemisphere receive sufficient rainfall because they are situated on the eastern side.

(2) Outside the tropics where the "Westerlies" blow, the western coasts are rainier than the eastern ones. The west of Europe, of Canada, and of the United States in the northern hemisphere, and of New Zealand and southern Chile in the southern hemisphere, have a heavier rainfall than the eastern parts.

(3) In the Equatorial Belt of Calms on account of high temperature the air is always rising. On reaching the upper regions of the atmosphere it is cooled and most of its water-vapour is condensed and fall as rain. Great heat and heavy rainfall and consequently luxuriant vegetation are the characteristic of this zone. The East Indies, the Congo Basin, and the Amazon Basin are regions of heaviest rainfall because they lie within this belt. The two large rivers, the Congo and the Amazon, owe their large body of water to this heavy rainfall.

(4) In the Calms of Cancer and Capricorn, which are the regions of high pressure, the air is always descending. As it comes from the cool upper regions to the hot lower regions, there can be no condensation through increase of temperature. Consequently there is no rainfall. Therefore, in or near these belts lie most of the dry deserts of the world. The deserts of Rajputana, Persia, Arabia, and California, as well as the Sahara, lie in the Calms of Cancer. The deserts of Australia, Kalahari, and Atacama (Chile) are situated in the Calms of Capricorn.

(5) The sun is vertical at the equator on March 21st and September 23rd. On these two dates, the equator is therefore the hottest line on the earth. During the rest of the year the hottest will be north or south of the equator, as the sun's rays are vertical towards the Tropic of Cancer or the Tropic of Capricorn. This line of greatest heat resulting from the vertical rays of the sun is called *Heat Equator* or *Thermal Equator*.

(2) Periodical Winds

The chief periodical winds are the Land and Sea Breezes and the Monsoons. The former blow for short periods, while the latter blow from season to season.

Land and Sea Breezes. During the day, the land is heated more rapidly than the sea. The air over the land is therefore hotter than the air over the sea. The atmospheric pressure is therefore lower on the land than on the sea. Consequently the cooler and heavier air from the sea blows towards the land as a sea breeze. It blows from the forenoon till sunset.

During the night, the land is cooled more rapidly than the sea. The air over the land is therefore cooler and heavier than that over the sea and therefore blows towards the sea as a land breeze. It blows from nightfall to early morning.

Monsoons

Monsoons or the seasonal winds, are those periodical winds which blow for about six months in one direction, i.e., from the sea to the land, and for other six months in the other direction, viz., from the land to the sea. During summer, i.e., in the month of May, June, July and August, the sun is vertical towards the Tropic of Cancer and therefore the heat equator, or the line of greatest heat, shifts northwards, i.e. over Mexico, Northern Africa, and Southern Asia. These land regions, especially the plains of the northern India, Laos, Cambodia North and South Vietnam and China, receive more of the sun's heat and have a lower atmospheric pressure than the waters of the Indian and Pacific Oceans situated near them. Thus the cooler and heavier air of these oceans blows towards the heated plains. The north-east trades which would otherwise blow over the Indian Ocean are totally overcome ; the south-east trades are drawn across the equator, and by the decreased rate of rotation are deflected to the right and blow over India from May to September at the South West or summer Monsoon. (Fig. 42). In China and Indo-China (Thailand, Malaya, Laos, Cambodia, North and South Vietnam) this wind blows as the South-East Monsoon. As it comes from the ocean this monsoon gives plenty of rainfall to India, China and Indo-China.

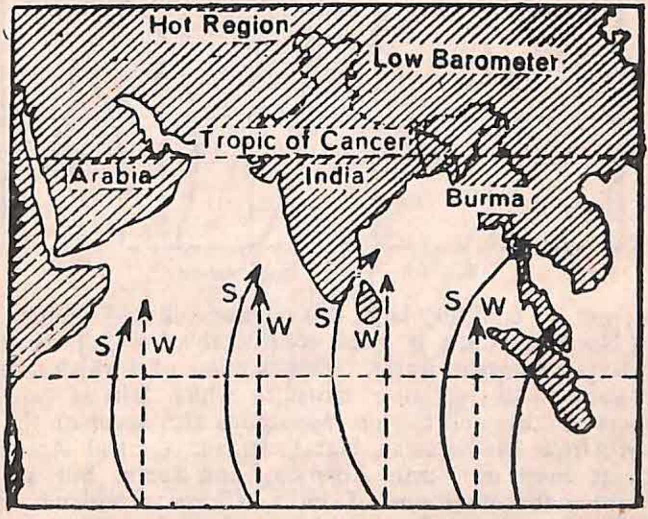

Fig. 42. The South-West Monsoon

During winter, i.e. in the months of November, December, January, and February, the sun is vertical towards the tropic of Capricorn and the conditions are therefore reversed. North Australia becomes a centre of high temperature and consequently low pressure, while the plains of India and China become very cold and have high pressure. The north-east trades are drawn southwards towards the equator and blow over India from November to April as a North-East or Winter Monsoon. (Fig. 43). Over China and North Australia it blows as a North-West Monsoon. As it comes from the cold, dry land, this monsoon is cold and dry. In the case of North Australia it gives considerable rainfall as it passes over a large expanse of water. This section of it which crosses the Bay of Bengal picks up some moisture which falls as rain on the east coast of India and Ceylon. Monsoons also occur on the Guinea coast of Africa, Madagascar, Natal, Brazil, Central America, the south east coast of North America, and Spain, but are not as important as the monsoons of India, China (Thailand, Malaya, Cambodia, North and South Vietnam) Indo China and Australia.

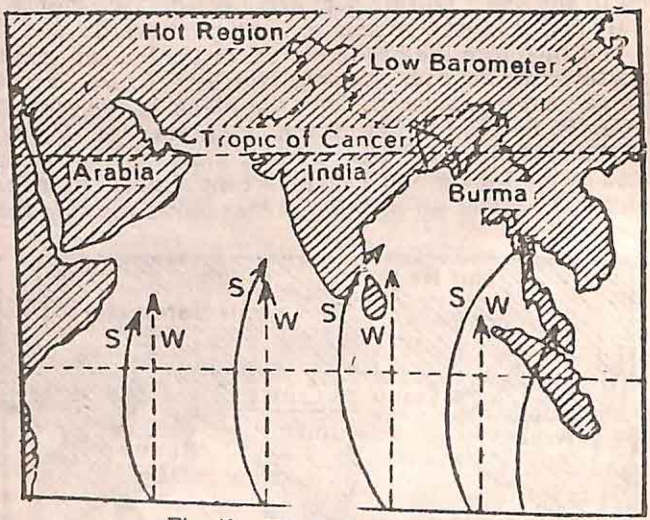

Fig. 43. The N. E. Monsoon

(3) Variable Winds

These include cyclones, anticylones and all local and miscellaneous winds as, for instance, the Simoon or hot wind of Arabia, the Siroco or hot wind of the interior of Africa, the Typhoons or circular storms in the China seas, and the Hurricanes or cyclonic storms in the West Indies.

Cyclones

Sometimes a small portion of the earth's surface becomes heated more than the surrounding parts. Thus a limited area of low pressure surrounded by one of high pressure is created. The cooler and heavier air from outside flows in towards the centre with a whirling motion and forms a *Cyclone* (see Fig. 44).

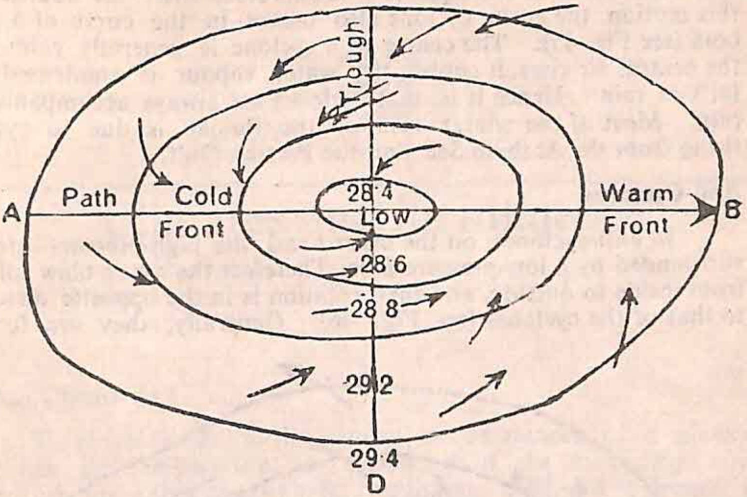

Fig 44. Cyclones

When south of the equator, this circular motion is clock-wise,

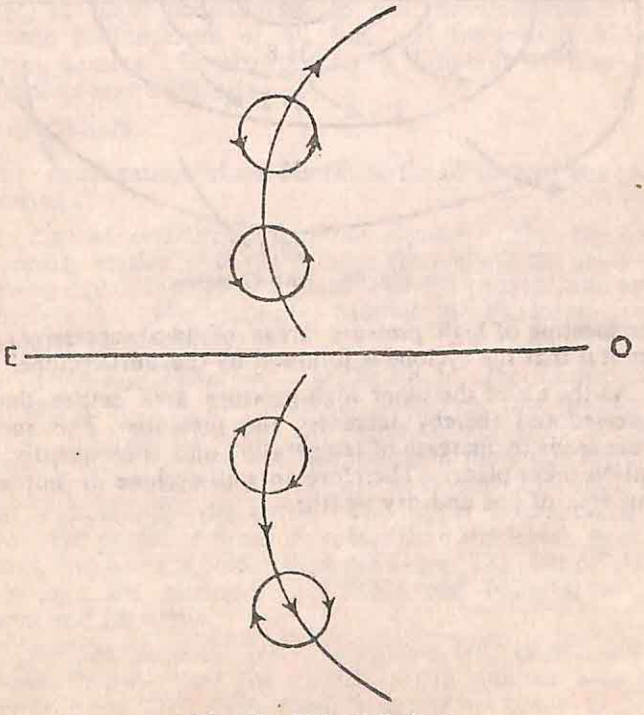

Fig. 45. Path of Cyclones

and when north of the equator it is anti-clock-wise. In addition to this motion, the entire cyclone also moves in the curve of a parabola (see Fig. 45). The centre of a cyclone is generally calm. As the central air rises, it cools ; the water vapour is condensed and falls as rain. Hence it is, that cyclones are always accompanied by rain. Most of the winter rain of the Punjab is due to cyclone rising from the Arabian Sea and the Persian Gulf.

Anti-Cyclones

In anti-cyclones, on the other hand, the high-pressure area is surrounded by a low-pressure area. Therefore the winds blow spirally from inside to outside, and their rotation is in the opposite direction to that of the cyclones (see Fig. 46). Generally, they are formed by the meeting of high pressure areas of two successive cyclones. Hence it is that the cyclone is followed by the anti-cyclone.

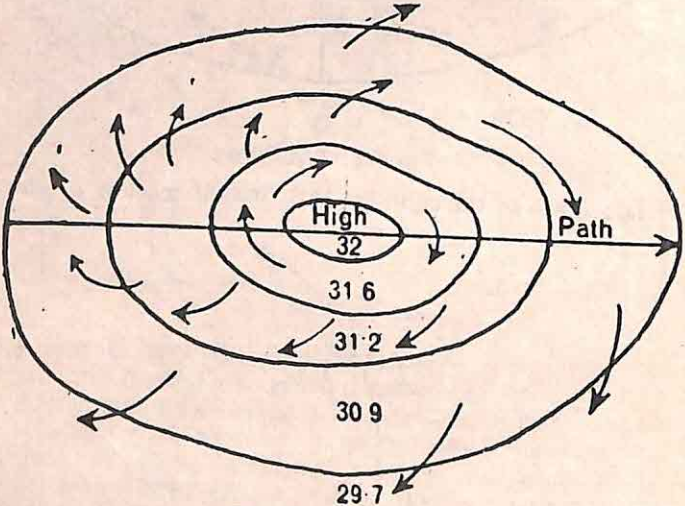

Fig. 46. Anti-Cyclones

As the air of the inner high-pressure area settles down it is compressed and thereby increases the pressure. This increase of pressure leads to increase of temperature and consequently no condensation takes place. Therefore an anti-cyclone is not a storm, but an area of fine and dry weather.

23

Climates and its Influence

What Climate is ?

By climate is meant the general circumstances of a place as regards its temperature, the character of the prevailing winds, moisture, and other atmospheric conditions. Briefly, it is generalised weather. Weather is the condition of the atmosphere at a particular time ; climate is the average condition of the weather for a long time and over a large area. A climate is said to be good when it is favourable to man, contributing to the full development of his powers, the prolongation of his life, and the fertility of the land upon which he lives. On the contrary, a climate is said to be bad when it affects man adversely.

Factors of Climate

The chief causes which determine the climate of any place are the following :

1. *Latitude or Distance from the Equator.* The sun is more or less nearly vertical over the equator throughout the year. Other things being equal, the nearer a place is to the equator, the hotter it will therefore be. For example, Madras and Bangalore are hotter than Calcutta and Bombay.

2. *Altitude or Elevation.* On the whole, the higher a place lies, the colder it will be. This is due to the fact that the upper layers of air are thinner. They can therefore not only absorb less heat than the lower layers, but also radiate it more quickly at night. Moreover, air is not heated directly by the rays of the sun, but by the heat radiated by the earth. The upper layers, being farther away from the source of heat, are colder than the lower ones. This is why mountains are colder than plains and the roof of the house is cooler than the ground-floor. Simla and Nainital are colder than Delhi and Lucknow.

3. *Distance from the Sea.* As water is both heated and cooled more slowly than the land, the sea is cooler in summer and warmer in winter than the land. The winds from the sea consequently make

the coastal places cooler in summer and warmer in winter than they would otherwise be. Hence the nearer a place is to the sea, the more equable its climate will tend to be. Bombay and Colombo, being on the sea coast, are neither hot in summer nor cold in winter, while Jodhpur and Kanpur, being farther inland, are very hot in summer and very cold in winter.

4. *Prevailing Winds.* If the winds come from the sea, the climate is equable and moist. If they come from the land, they are dry and are therefore hotter in summer and colder in winter. In India, the north-east monsoons come from the land; they are therefore dry and make the climate colder. But the south-west monsoons come from the sea and so bring copious rains and make the climate moist.

5. *Direction of Mountains.* If the mountains run in the same direction as the prevailing winds, the latter pass on without being checked. The Aravalli hills in Rajputana run from north-east to south-west, in the same direction as the south-west monsoons. Accordingly these monsoons blow over unchecked to the Siwalik hills without shedding a drop of rain in Rajputana. On the other hand, if the mountains run at right-angles to the prevailing winds, they check these winds and cause rain. The Himalaya intercept the cold winds of the north and thus protect the Indo-Gangetic plain from their benumbing effect. Where the mountains check the warm and moist winds, they are rainy on the windward side and dry on the leeward side. The Western Ghats check the south-west monsoons laden with moisture, and cause heavy rainfall on the Bombay side and practically no rain on the Deccan side. Similarly the southern slopes of the Himalayas have 80 inches of annual rainfall in some places, while the northern slopes have only 30 inches.

6. *Amount of Rainfall.* Rainfall may be due either to radiation or to relief. Radiation rainfall is always caused by the cooling of air containing moisture. When a current of damp air rises into the upper and cooler regions of the atmosphere it is cooled not only by its passing into cooler regions, but also by its expansion owing to the diminished pressure in the higher layers. Thus places situated in the equatorial belt of low pressure, where the air is always ascending on account of the great heat, have very heavy rainfall.

Relief rainfall is caused by the mountain ranges which lie in the path of the moisture-bearing winds and force these winds to rise in order to cross the barrier. In rising high, they cool and relieve themselves of their moisture. The higher and steeper the barrier is, the heavier is the rainfall, and consequently the more moist is the climate.

7. *Ocean Currents.* Warm currents give a warmer climate to the places near which they pass; cold currents have the opposite effect. The British Isles enjoy an almost equable climate throughout the year on account of the influence of the warm Gulf Stream Drift, while other countries in the same latitude experience extremes

of heat and cold. Similarly the Kuro Siwo current warms the eastern shores of Japan and the west coast of North America. On the contrary, the cold Benguela and Labrador currents make the climates of the west coast of South Africa and the east coast of North America respectively much colder than they would otherwise have been.

8. *Slope of the Land.* In the northern hemisphere, the southern slopes of a mountain receive the rays of the sun more nearly vertically and are consequently much warmer than the northern slopes. In the southern hemisphere the reverse is the case. Thus the best grapes ripen on the southern slopes of Algeria and on the northern slopes of the Cape of Good Hope. Similarly Siberia, on account of its slope towards the north, that is, away from the sun, is colder than it would otherwise be.

9. *Nature of the Soil.* Sandy soil is much more rapidly heated and cooled than damp clayey soil. Rajathan with its sandy soil, is therefore much hotter during the day and much colder during the night than Bengal in the same latitude,owing to the latter's damp clayey soil. Similarly the range of day and night temperature of Bikaner is much greater than that of Shahjahanpur in the same latitude.

10. *Vegetation.* Trees have a great effect on rainfall and consequently on the climate. They produce a coolness in the air around them and thus help in condensing the water-vapour present therein. The forest area of the world are regions of very heavy rainfall. The Congo Basin in Africa and the Amazon Basin is South America have dense forests and consequently very heavy rainfall. India, which was once well covered with forests, is said to have now a much drier climate than it formerly had. Famines due to lack of sufficient rain would therefore be more frequent now than they were in the past, if preventive measures were not adopted. For this reason, the Government of India now takes great care of the forests of India. Instances are not wanting where large areas which were once well watered have been rendered almost rainless by the destruction of the forests

Factors of Rainfall

From the above, it will be clear that temperature and rainfall are the chief constituents of climate. The circumstances which determine the rainfall of a place may be summed up as below :—

(a) *Situation.* If a place is situated where the air is ascending and the evaporation is great on account of great heat, as in the Doldrums, the rainfall will be heavy. Where the cold is great and the evaporation is absent, as in the Tundras or cold regions along the Arctic Sea, there is no rainfall.

(b) *Nearness to the Sea.* As the air coming from the sea brings moisture with it, places near the sea have generally more rainfall than those situated farther away from it. Madras is wetter than Mysore.

(c) *Prevailing Winds.* If the prevailing winds are warm and moist they bring rain, and if they are cold and dry they bring no rain. Bombay, which is under the influence of the warm moist south-west monsoons, has a heavier rainfall than Delhi, which is subject to the cold winds of Central Asia.

(d) *Direction of Mountains.* If the mountains run in the same direction as the prevailing winds, there is no rainfall ; but if they lie at right angles to the winds they check the winds and bring about a rainfall. The Satpuras and the Vindhaya Mountains run east and west, that is, in the same direction as the Arabian Sea monsoons. They therefore allow the monsoons to pass on and so get no rainfall; while the Western Ghats which meet the monsoons at right angles have heavy rains.

(e) *Currents.* Warm currents increase rainfall, while cold currents decrease it. The eastern coast of South Africa, along which the warm Mozambique and Agulhas currents pass, receives more rain than the western coast, near which the cold Benguela current flows.

(f) *Vegetation.* We have shown in a previous paragraph how greatly trees and forests affect rainfall.

Distribution of Rainfall

Taking into consideration the above factors of rainfall, we can easily discover whether the rainfall of certain areas is likely to be abundant or scanty.

Regions of Heavy Rainfall

(1) The places that are situated in the Doldrums or the Equatorial Belt of high temperature, low pressure, and ascending air, are the East Indies, the Congo Basin and the Amazon Basin.

(2) The regions where the moisture-bearing winds blow. They are the Western Ghats, the Himalayas, and the Khasi, Garo and Jantia hills of Assam, where the south-west monsoons blow ; Japan, East China, and Indo-China (Thailand, Malaya, Laos, Cambodia, North and South Vietnam) where the north-east monsoons blow ; north-east Australia, south-east Africa, the Brazilian coast of South America, and Florida in North America, where the trade winds blow; New Zealand, Cape Colony, Southern Chile, the west coasts of North America and Europe, where the westerly winds blow. It is worthy to note that at Cherrapunji on the Khasi hills of Assam the annual rainfall is about 500 inches, the heaviest in the world.

Regions of Scanty Rainfall

(1) The places that are situated in the Calms of Cancer and Capricorn. Here, on account of high pressure the air is always descending from cooler regions to warmer regions and therefore no

rain falls. Rajasthan, Persia, Arabia, the Sahara and California in the Calms of Cancer ; and the Australia, Kalahari and Atacama deserts in the Calms of Capricorn, are the notable examples.

(2) The regions that are situated :

(a) on the leeward side of mountains, or

(b) in the interior of continents beyond the reach of the moisture-bearing winds.

The chief examples of the former case are the Deccan, situated on the leeward side of the Western Ghats ; Tibet, sheltered by the Himalayas ; and the Great Basin of the United States protected by the Rocky Mountains; Gobi or Shamo Turkey, situated in the heart of Asia, are instances of the latter case.

Types of Climate and Climatic Regions

Before giving a brief description of the chief types of climate distributed over the surface of the earth, we must remember that climate changes gradually from one type to another, and so no exact limit can be fixed between one type and its neighbour. Many regions have climates intermediate between the types that are described below :—

1. *Equatorial Climate.* Although the equatorial belt of high temperature, low pressure, ascending air, and heavy rainfall moves northward and southward with the sun, certain regions on either side of the equator always lie within it. Such are the Malaya Archipelago and the basins of the Amazon and the Congo. Here the temperature is very high and the annual range of temperature between the hottest and the coldest months is very small. The rain is costant and heavy and there is no dry season.

2. *Sub-equatorial or Tropical Climate.* The regions in which this type of climate occurs lie on both sides of those where the equatorial type prevails. Owing to their greater distance from the equator, these regions are within the belt of equatorial rainfall for one part of the year and outside it for another. They have therefore sufficient rainfall in their summer when the heat is very great. For the remaining part of the year, when the heat is less, the season is rather dry. Thus there are two seasons, the wet and the dry. The temperature is high throughout the year. This type of climate prevails in the Deccan, the Sudan, Nigeria, Guinea and Venezuella in the northern hemisphere, and in the Zambezi valley, southern Brazil, Paraguay, and Uruguay in the southern hemisphere.

3. *Monsoon Climate.* This type of climate is very similar to the tropical type and prevails in those tropical regions where the monsoons blow. The summers are hot and rainy, but the winters are comparatively dry. Owing to the great area within which the monsoons occur, several sub-types exist. Bombay, which has a high mean temperature, low range, and heavy rainfall ; Canton, which has a lower mean temperature, greater range, and a moderate rainfall ; and Peking which has hot summers and very cold winters, are the

principal examples of the sub-types. The regions of monsoon climate are India, Indo-China (Thailand, Malaya, Laos, Cambodia, North and South Vietnam), China, Japan, Natal, north-eastern Australia, and the south-eastern portion of the United States.

4. *Hot Desert Climate.* This type of climate is found in the regions lying in or near the Calms of Cancer and Capricorn belts of high pressure, and in the interior of continents beyond the reach of moisture bearing winds. The principal examples are the deserts of Rajputana, Persia, Arabia, Gobi or Shamo, the Sahara, and California in the northern hemisphere, and the Australian, Kalahari and the Atacama deserts in the southern hemisphere. Here the climate is hot and dry. The days are extremely hot and the nights extremely cold. The annual and the diurnal ranges of temperature are great.

5. *Mediterranean Climate.* Owing to the movement with the sun of the various belts of high and low pressure, certain regions approximately in latitude 28 degrees to 40 degrees in both hemispheres come within the range of the trade-winds in summer and of the "westerlies" in winter. The trade-winds coming from the cold and dry places do not bring any rain, but the "westerlies" coming from the ocean bring plenty of rain to the western coast. Thus summers are hot and dry and winters are mild and rainy. As this type occurs extensively in areas around the Mediterranean Sea it is known by the name of Mediterranean Climate. It prevails in southern Europe, Northern Africa, California, Central Chile, Cape Colony, and South Australia.

6. *Temperate Climate.* This type of climate occurs in higher latitudes than the Mediterranean lands, temperate regions have cooler summers and colder winters than the Mediterranean regions. There are two sub-types of this climate ; (a) the warm temperate, in which the mean annual temperature does not fall below 50 degrees F., and (b) the cold temperate, in which the mean annual temperature is below 45 degrees F. On the western coast of the regions of both types the "westerlies" which come from the ocean are the prevailing winds. Here the summers are cool and the winters mild, and the rainfall is uniformly distributed throughout the year. Such a climate is called an Oceanic or Maritime climate and is found in western Europe, British Columbia, Southern Chile and Tasmania. In the interior of these regions the summers are hot, the winters severe, and the rainfall, which falls chiefly in summer, is low. Such a climate is called a Continental Climate and occurs in Siberia, Central Canada, and the central United States. In the coastal regions to the east of these continental regions a moderated continental climate is found. Owing to their nearness to the sea, such regions receive a heavier rainfall and snowfall due chiefly to cyclones. As the winds blow from the land to the sea, and cold Labrador and Kurile currents flow along the shores, the winters are very severe. Such a climate is found in Eastern Canada and in Manchuria.

7. *Tundra or Cold Desert Climate.* This type of climate occurs in the regions lying along the Arctic Oceans and called the Tundras. The northern parts of these regions remain frozen throughout the year and the southern parts are intensely cold. Even in summer it is never warm and the winters are bitterly cold. Their mean annual temperatures are the lowest known.

8. *Mountain Climate.* The climate of the mountains differs from that of the plains in all parts of the world. On account of the great elevation, the temperature and the pressure of the air are lower and generally a more abundant rainfall occurs. Very high mountain regions, specially near the Equator, have many varieties of climate in succession, from the hot moist equatorial type down to the Tundra type. Quito in South America, though situated on the equator, enjoys a mild climate simply on account of its elevation.

Local Variations of Climate

In addition to the climatic types named above, there is an infinite variety of climates due to local conditions. Most of these local variations are caused by mountains. Thus in Turkey there is in winter a warm south-west wind blowing above the cold north-easterly winds from Siberia ; the temperature therefore increases upwards, and the inhabitants climb the hills when the cold in the plains becomes unbearable. Lakes also have a local effect, as in the case of the moderating influence of Lake Baikal. Even the smoke and fires of large towers and the reflection of the sun's rays from walls help to raise the temperature above that of the surrounding country.

Influence of Climate

No single geographical factor exercises a greater influence on the economic development of a country than does climate. It closely concerns the daily·life of man, his food, clothing, dwelling, occupation, industry, commerce, and physical and mental characteristics.

Its two most important constituents, viz. moisture and warmth, are primary essentials to the vegetable and animal life upon which human existence depends. How different climates affect differently the life and activity of man is shown briefly, though perhaps too strongly, in the following words :

"In the Arctics you get nothing for something, in the tropics something for nothing, while in the temperate regions you get something for something."

Let us take these three principal climatic regions separately :

(a) *Arctic Region.* In this region, on account of the excessive cold, food is very scarce. The hunting of the reindeer and the polar bear is the only occupation of the few inhabitants. Clothing and shelter, however simple, cannot be easily procured. With all their efforts and their cleverness these people lead a hard life. Leisure is essential to all progress. Where it takes men all their time to earn a bare living, there is not much room for improvement. As their hard conditions of life leave them no leisure, these people are very low in the scale of civilisation.

(b) *Tropical Region.* Here, on account of the great heat and moisture, food is produced in abundance. Moreover, as the same quantity of food can support more people in warm than in cold climates, less food and clothing are required here. Life in such regions is therefore very easy and there is little to compel men to be active, industrious and enterprising. They are for the most part content if they have food enough for the day. Their wants are simple and easily satisfied and provide no spur to ambition.

(c) *Temperate Region.* In this region man cannot live without effort. Life here is neither so hard that man has no chance, nor yet so easy that he has no stimulus to work. The climate does not, like that of the tropics, weaken him and make him indolent, nor does it, like the arctic climate, put such a strain upon him that he has no time and strength left after securing his bare living. Moreover, it has been proved that the changes of the seasons and even the changes of weather from day to day in temperate regions are invigorating both to body and mind. The dwellers in temperate regions are therefore on the whole active, energetic and industrious. As all human progress depends upon activity of mind and body, these people are far advanced in science and art and thus tend to dominate the world.

PART III

PRACTICAL GEOGRAPHY

24

Scales—Their Meaning And Construction

Necessity of having a scale

The map is the chief instrument of learning and teaching geography. In fact a map is the shorthand of geography. In a map the area that it represents is much smaller than the actual area but it is at the same time quite proportionate in every detail to the original surface. Such a map whose dimensions are in proportion to the actual land area is said to have been drawn on a scale. A map without a scale is meaningless and it becomes a rough sketch. In order to be accurate in every respect the map should always be drawn to a scale.

Definition

A scale expresses the proportion which a length between two points on the map bears to the actual distance between similar two points on the ground. Suppose the distance between the General Post Office and Jama Masjid in Delhi is one mile and we show these two points by one inch line on the map, then the relation that exists between these two distances will be called the scale of the map. In the above case it is one inch to one mile. In simple words, it means that one inch on a map represents one mile on actuall and.

Methods of expressing scales

The following are some of the common methods of expressing the scale on the map :

1. *The statement of scale* : This implies only a statement e.g. one inch equal to one mile. This is the simplest method of indicating scale on a map. The scale may be large or small. Small scale maps are used when very large areas are represented on a very small map space e.g. 1″ to 500 miles. On the other hand, large scale maps show smaller areas on larger map spaces e.g. 1″ to a mile. Survey maps, plans, etc. are on larger scales.

2. *Line or plain scale* : This method shows the scale in a graphic form. It consists in dividing a line into an equal number of

parts to show miles or any other units desired. One of the major divisions is sub-divided into equal number of parts to show yards or miles, etc. The aim should be that each part should represent some round figure as 5, 10, 15, 20, etc. On the map the scale is shown either at the top or at the bottom in any one form as shown in the following Figures (47, and 47A). The secondary divisions in this scale are always made on the left hand side and the start for major divisions is made with zero. Thus the position of zero is on the extreme left of primary divisions or on the extreme right of the secondary divisions. This is the most common method practised.

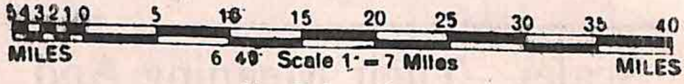

Fig. 47. Line Scale

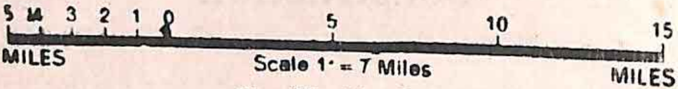

Fig. 47A. Line Scale

Method of constructing a line scale

Let us construct a line scale for 1" = 7 miles. If 1" is equal to 7 miles, then 6 inches will be equal to 42 miles. Always take some nearest whole number of this figure. In this case it is 40. Now if we divide 40 into 8 equal primary parts then each part represents 5 miles. In order to divide a primary into secondary divisions, we should add one more part. Thus the total number now comes to 40 + 5 = 45 to be divided into 9 parts so that each part may show 5

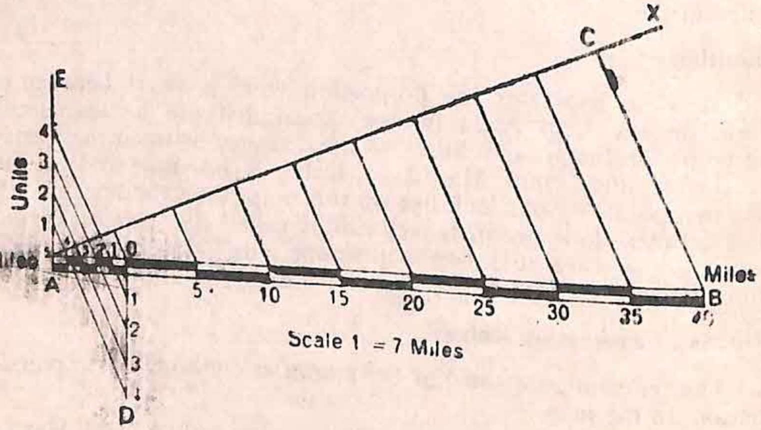

Fig. 48. Diagram showing construction of Line Scale

miles. Then if 7 miles are represented by 1" then 6.4 inches will show 45 miles. Then take a line AB 6.4 inches long and make an angle BAX (Fig. 48). Mark 9 equal divisions on the line AX, last point being C. Join BC. With the help of set squares, draw parallels to BC from each division so that the line AB may be divided into 9 equal parts. Leave one part on the left hand side and mark the next as zero and proceed as 5, 10, 15 and 20 miles. In order to make secondary divisions draw two perpendicular in the opposite direction from O and A respectively. Then mark 4 equal divisions (one less than the actual number required) on AE and OD. Then join points 1 with 4, 2 with 3, 3 with 2 and 4 with 1. The line AO will thus be divided into 5 equal parts. Thus the whole line is divided and it enables us to measure any distance.

3. *Representative Fraction.* In this method, the relationship between the distance on the ground and the length of the map is shown by a fraction, while in the statement method it is expressed in the form of an equation. Such a fraction is known as the Representative Fraction and is usually abbreviated as R.F. e. g. RF=Map length/Ground distance or 1/63360, (1 miles=63360 inches). This means that one unit of length on the map is equal to 63360 units on the ground. It may mean that 1 cm on the map is equal to 63360 cms. on the ground. It should be remembered that the denominator and the numerator should be in the same units and the numerator is always 1. They are also the lowest units in the table. This is the most suitable method of indicating a scale as it can be expressed in any unit desired and not only in inches or feet or miles or yards. Now a German or a Japanese will not be able to follow the scale if expressed only by a statement. On the other hand, he can very easily follow the scale if expressed in a Representative Fraction, because in this case he can convert the denominator and the numerator in the units which he understands. Thus we have seen that this method is of universal application. Besides, the method easily lends itself to conversion of the statement of R.F. and *vice versa.* The following are some simple examples in conversion :

1. From R.F. to statement.—To find

(a) The number of miles to an inch.

(b) The number of inches to a mile.

(a) Divide the denominator of the fraction by 63360. It should be remembered that one mile is equal to 63360 inches.

e.g. If R.F. is 1/1,000,000 then, 1,000,000/63360=15.79 miles ; therefore the statement of the scale is 1"=15.79 miles or 16 miles approximately. Scale 1"=16 miles approximately.

(b) Divide 63360 by the denominator of the fraction.

e.g. if R.F. is 1/50,000 then 63360/50,000=1.27 inches.

Therefore the scale is 1.27"=1 mile.

2. From statement to R.F.

(a) When number of miles to an inch are given :

The rule is to multiply 63360 by the number of miles in the given scale and this will give the denominator of the R.F.

Scale given is 1″=5 miles.

then 1″=5×63360 inches

therefore, R.F. is 1/316800.

(b) When number of inches to a mile are given :

Divide 63360 by the number of inches to the mile in the given scale and the resulting number will be the denominator of the R.F.

Example. Scale given 2 inches to a mile.

According to the rule=63360/2=31680 inches, therefore. R.F. is 1/31680.

25

Elementary Surveying

Meaning of the term "survey"

When a map of a certain area is to be prepared, its dimensions have to be measured first. If the area is very small, it is easy to take measurements with a foot rule or a yard stick or even a tape, but if the area to be represented on a map is large, it is necessary to use other measures. Such a convenient measure is the chain. Thus the terms "surveying" means methods of taking measurements in the fields which will form the basis of a map marking. In technical language it is defined as "the science which determines the boundaries and superficial extent of any portion on the surface of the earth." Some of the methods of surveying are :

(1) Chain survey,

(2) Plane table survey,

(3) Prismatic compass survey.

1. Chain Survey

When we measure the boundaries of a certain area whose map is to be prepared purely with a chain it is called Chain Survey. This type of survey requires the following instruments :

1. *Chain and arrows* : There are three kinds of chains that are in common use, the 50 feet chain, the 66 feet chain, and the 100 feet chain. These chains are made of metal and are meant for rough use. Out of these three the 66 feet chain, also known as Gunter's chain, is the most popular. It consists of 100 links with a tab fixed at every tenth link. The total length of the Gunter's chain is 22 yards or 66 feet. Thus, each link is equal to about 9 inches. In other chains mentioned above, each is one foot long. Besides the chain, small arrows made of steel are also needed. These are used for fixing a point.

2. *Tape*. A tape is used in conjunction with the chain.

3. *Field Book*. This is a notebook for entering measurement

readings taken during survey in the field. It has two parallel lines in the middle at the page ½ inch apart.

The column thus formed corresponds to the lines walked by the surveyor (Fig. 49). The entries are made from the bottom of the column and proceed upwards. At every turn of the line of survey, a short line is drawn in the chain column and the turnings are marked as A, B, C, etc. The offsets are entered on the right or left of the chain column as the case may be.

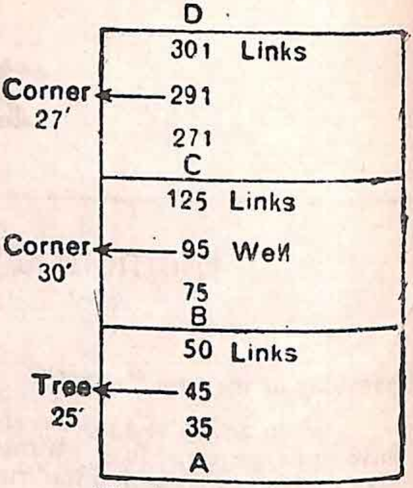

Fig. 49. Field Book

4. *Flags or poles*—Coloured flags or graduated poles are used to fix positions.

Methods of Surveying

In order to survey the irregular school ground A.B.C.D.E it is necessary that you should look round the field and draw an outline plan of it. Write down letters A, B, C, D and E at each corner. (Fig. 50). Now measure the diagonal AD by fixing two poles one at

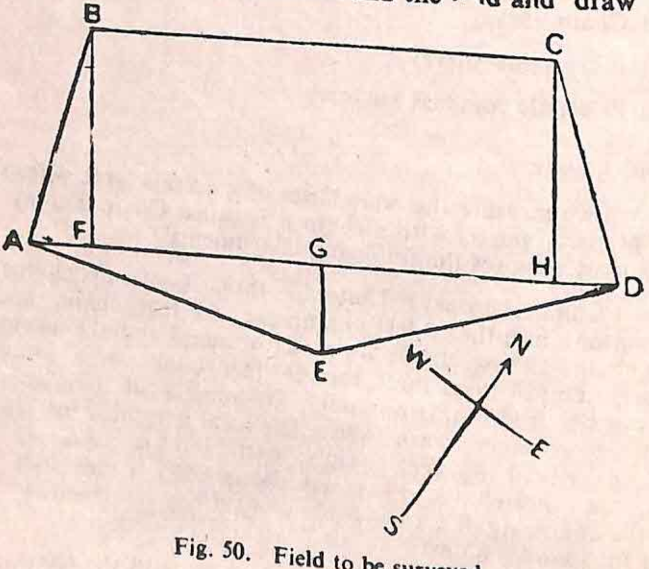

Fig. 50. Field to be surveyed

A and the other at D. Stretch your chain along the line AD. The person who carries the chain towards D is known as the leader and the other who stands at A and follows the leader is known as the follower. When the chain is stretched, the leader turns towards the follower who guides the leader with hand signs to be in line with AD. When the chain is fully extended the leader fixes an arrow at his position. The follower occupies the position of the leader (judging from the position of the arrow) who moves ahead towards D point.

Offsets

At certain intervals along AD, perpendicular distances are measured with the help of flags and tape. These are known as offsets. In order to mark the position of B, fix a flag there. Then at an interval of AF, measure the perpendicular distance BF with the help of a tape. Similarly measure perpendicular distances GE and HC. Thus you have been able to fix on the map the corners A, B, C, D and E by taking offsets to B, C, and E, from the main path AD.

North and South Points

Setting of map is an important item in map work. It means that the North point of the map must correspond to the actual North pole. Therefore, in order to draw North and South points we use a box compass. It consists of an oblong metal box with a magnetic needle suspended freely over a pivot, which is fixed in the centre of the box. The lid of the box is made of glass to enable one to look through the position of the needle. The magnetic needle, when freely suspended, always points towards North and South. In order to mark North and South points, one has to draw only the outline of the box and make two arrows on the boundary lines pointing towards the north side. When rough readings have been entered in the field book, the actual plan can be prepared from these measurements. The map is so set that its top usually corresponds to the actual North. A convenient scale is taken according to the size of the paper used.

2. Plane Table Survey

This method is also simple and is more accurate than the chain survey. It is also a valuable means of filling in the details of the area shown in the map. The following instruments are used (Fig. 51).

1. *Plane table and tripod Stand* : It is a drawing board 18″ × 24″ fitted on a tripod stand 4 feet high. Its legs should be strong and rigid.

2. *Alidade* : It consists of a ruler, graduated or ungraduated, made of wood or metal. At its two ends are fixed hinged sights. The front sight has a wire fixed vertically through a wide slit and the back sight has only a narrow vertical slit.

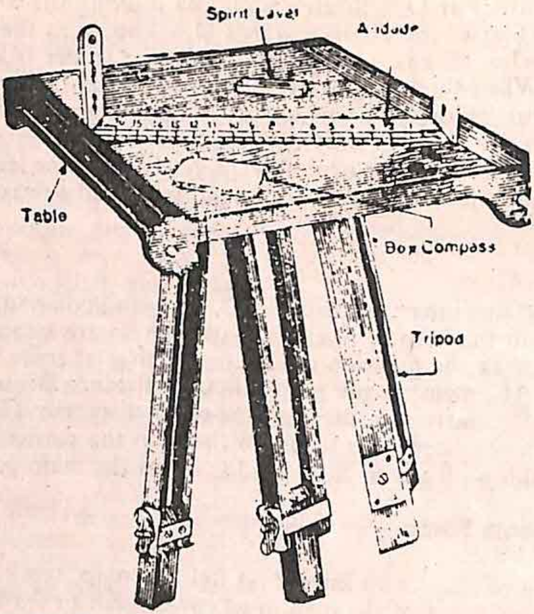

Fig. 51. Plane Table, Spirit Level. Box Compass and Tripod

3. *Box Compass* : It is used for setting the map.
4. *Spirit Level* : This is employed to make the table to level.
5. *Poles or flags* are used for fixing positions.
6. *Chain and arrows* : With the help of these distances are measured.

Method of Surveying

First of all a suitable position A is chosen in the field by the surveyor. This is the point from where a good view of the area can be had. The table with a big piece of paper pinned on it is levelled at this position. Then another point B on the ground is selected where-from again the whole view is to be had. The position of the point A is marked on the paper by fixing a pin vertically above the point A. The distance between A and B is measured with Gunter's chain and is drawn on the paper according to some convenient scale. Then with the help of sight rule or alidade, all the points to be entered are sighted and their rays are drawn from A. Before the table is moved to position B, the map must be oriented with the help of box compass. It means that the North point is to be shown on the map. When the table has been shifted to position B, the whole order is repeated. The table is levelled and reoriented to avoid any discrepancy. Then rays from the same point are drawn at B with the help of the sight rule. The point of intersection of the set of rays will locate on the paper the actual positions of objects. These points when joined will give us the map of the area desired.

3. Prismatic Compass Survey

The prismatic compass is a circular box graduated in degrees containing a magnetic needle. The direction of the object is measured by pointing the compass in line with the object and taking the readings from the prismatic compass. In order to measure distances, the chain is stretched on the ground along which the surveyor walks. These readings are entered in the field book as explained before and finally the actual map is prepared on some suitable scale.

26

Survey of India Maps and other Maps

Maps may be classified according to :

(1) the scale of the maps, they show and are called Scale Maps,

(2) the subject or theme they show and are called Thematic Maps.

1. *Scale Maps* : These are of the following types :

(a) Cadastral maps are drawn on a very large scale upto 25 or more inches to a mile.

(b) Topographical maps are also drawn on a large scale. The scale ranges from 1″ to 4″ or, more inches to a mile. The survey maps fall under this category.

(c) Chorographical maps are small scale maps of the various parts of the world showing typical features by conventional signs. Our atlas maps fall in this category.

(d) World maps are also small scale maps showing the whole world.

2. *Thematic Maps* : These maps are classified according to some important features which they show. The main types are :

(a) An outline map shows only the boundaries of the countries and continents.

(b) A political map shows the political boundaries of province, listricts, towns, roads and railways, etc.

(c) A relief or physical, or orographical map represents the nature of the land surface by means of contours and colour tints.

(d) A bathymeteric map shows the depths of the oceans with tins of blue colour.

(e) A bathy orographical map is a combined map showing depths of oceans and heights of land surface.

(f) An ethnographical map locates the distribution of the races of mankind.

(g) A vegetation map is one showing the distribution of natural vegetation.

(h) A biological map shows the distribution of flora and fauna.

(i) A weather map is a map showing the distribution of temperature, pressure and rainfall for a short period only.

(j) A climatic map shows either the distribution of temperature or rainfall or pressure or winds or a combination of all these for a particular season as, for example, a map of India showing winter or summer temperature.

(k) A distributional map shows the distribution of some commodity or stock or crops.

(l) A commercial or economic map shows the area of production, distribution of exports and imports, density of population, railways and other routes.

(m) A geological map shows the distribution of rocks. Geology is the science which studies rocks.

(n) A topographical map or ordnance survey map is a large scale map showing the details of relief of topographical features and drainage.

(o) The international map is an ordnance survey map drawn on a scale 1=1000,000. It is divided into sheets having uniform scales and signs. Each sheet, showing some parts can be fitted with other sheets to show the country as a whole. It is drawn with the co-operation of the various countries of the world.

Survey of India Maps and How to Read them ?

The Survey of India have prepared large scale maps of nearly all the parts of India and the adjacent lands. These maps show greater details of relief (high and low land surface) and drainage, etc. Conventional signs and symbols are employed to show these various types of details. The ordnance survey maps are not very difficult to be recognised because of certain common characteristics. For instance every sheet bears its own sheet number and a scale. Even the signs and symbols which are employed, differ considerably. These maps are prepared on the principles of plane table and triangulation survey. The whole country is divided into triangles by means of theodolite. Triangulation is a system of measurement based on the truth that if one side and two angles are known, the lengths of other two sides can be calculated. The word ordnance means cannon or artillery. Since these maps are of great value to military personnel the word 'ordnance' is used. Each sheet contains 4 degrees of latitude, and 6 degrees of longitude up to 60° lrtitude. From 60° to 80° latitude, each sheet shows 4 degrees of latitude, but 12° of longitude. There are various types of ordnance survey maps. The best known and the most popular is the one inch map. There have been various editions of this map. The other maps are 6 inches, 25 inches to a mile and 1 inch to 1 million inches. These maps differ from one another in the use of conventional signs.

Map reading

Since map reading is an important part of geography teaching in schools, it is desirable that some introduction to Indian Ordnance Survey maps be made and their reading practised by setting some suitable and well graded series of questions and exercises. Map reading may be done in the following systematic order:

1st Step

Marginal information: The following information must be gathered from the map:

(a) The sheet number.

(b) The name of the area shown.

(c) The scale usually drawn at the bottom of the map.

(d) Calculate the area of the region shown.

(e) Note the conventional signs entered therein.

Conventional signs: Following are some of the common standard signs that are employed by the Survey Department of India.

(a) Roads are shown by continuous lines. Paved roads are represented by continuous lines and unpaved by dotted lines.

(b) Railways are shown by double black lines with short ticks in between them.

(c) Rivers and canals by blue lines.

(d) Trees are shown by sings of trees. An orchard is expressed by drawing these trees in some order.

(e) Buildings are represented by solid block or red colour. There are other symbols also. For instance, P stands for Post Office. T for Telegraph office. Usually, all the conventional signs and symbols that have been employed in a map are shown on that particular sheet.

2nd Step

Study of the Physical geography of the region: In this step the relief of land is studied with the help of contour lines or layer tints or hill shading. Even spot heights do convey some meaning of the topography of the land. Stopes, heights, waterfalls, the shape of valleys and gaps, etc., be interpreted from the map. Next comes the hydrography or drainage system of the region. The names and direction of the rivers have to be noted down. The existence of lakes, tanks, wells and and water partings have to be found out. If it is a coastal area then coastal features are to be studied. When sufficient practice is gained, attempts should be made to reason out the nature of rocks and soil present there.

3rd Step

Vegetation: Since vegetation is determined by physical factors like relief, climate and soil, it will not be difficult to describe the vegetation of the regions.

4th Step

Human Geography : Here the aim is to interpret the actions and inter-actions between man and physical factors. This is done by drawing sketch-maps of communication, and human settlements. It involves study under the following heads :

(a) *Historical Geography* : In order to know the history of the land, resort has to be made to the presence of forests, old buildings, temples, churches, burial grounds and other monuments.

(b) *Agriculture and Land Utilization* : The whole land shown is classified into :

(i) Forested area
(ii) Marshy area
(iii) Arable land
(iv) Pasture land and
(v) Desert land.

Irrigation works are studied from canals and tubewells shown therein.

(c) *Means of Communication* : The development of the land is judged from the existence of railway and roads, sea and airways.

(d) *Human Settlement* : The sites of towns are examined and if possible geographical causes are put forward for the growth of towns.

(e) *Industries and Occupations* : The existence of mills, factories and mines, will determine the cultural stage of the region. This will enable the map reader to judge the main occuption of the inhabitants also.

5th Step

Conclusion : Finally, the whole area studied is divided into its natural regions keeping in view the relation between the physical factors and man. The teacher of geography should aim at enabling the child to read a map independently. He should in the initial stages offer assistance to the students in studying survey maps of areas known to his pupils.

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27

Maps and other Geographical Illustration

Almost every type of geographical data can be expressed in the form of maps. Geographical data can be of three types : Climatic data. Distributional data and Topographical data. Maps are named after the data they represent. A climatic map is one which shows data relating to climate e.g. temperature, pressure and rainfall. A distributional map may show the distribution of stocks, crops, minerals and population. Their aim is to show the variations in value and amount or density of different dis~~tribut~~ion. A topographical map will show data concerning relief, e.g. heights and depths.

1. Climatic maps and illustratations

These maps show the distribution of temperature, pressure and rainfall. The distribution of temperature is shown by means of isotherms, by isobars and rainfall by isohyets. Such maps are known as climatic maps, average temperatures and pressures for different hours of a day or for different days of the month or for different months of the year, are represented by temperature and pressure graphs respectively. For comparison purposes, two or more graphs in different colours are drawn in the same diagram. For instance, you may show the maximum and minimum temperatures of a place in a single diagram. Let us make an attempt to prepare a temperature graph to show the following average temperatures for different months of the year.

Jan.	37°F	July	51°F
Feb.	30°F	Aug.	57°F
Mar.	40°F	Sept.	53°F
Apr.	55°F	Oct.	46°F
May	49°F	Nov.	40°F
June	54°F	Dec.	38°F

Draw two lines AB and AC at right angles to each other (Fig. 52). The horizontal line AB will show the time element and the vertical line AC the actual temperature readings. Therefore along AB mark off at equal intervals letters J.F.M. etc. referring to the names of the months. Along AC write figures 30, 35, 40 and 45 at equal distances. On the vertical line marked J, put a small cross

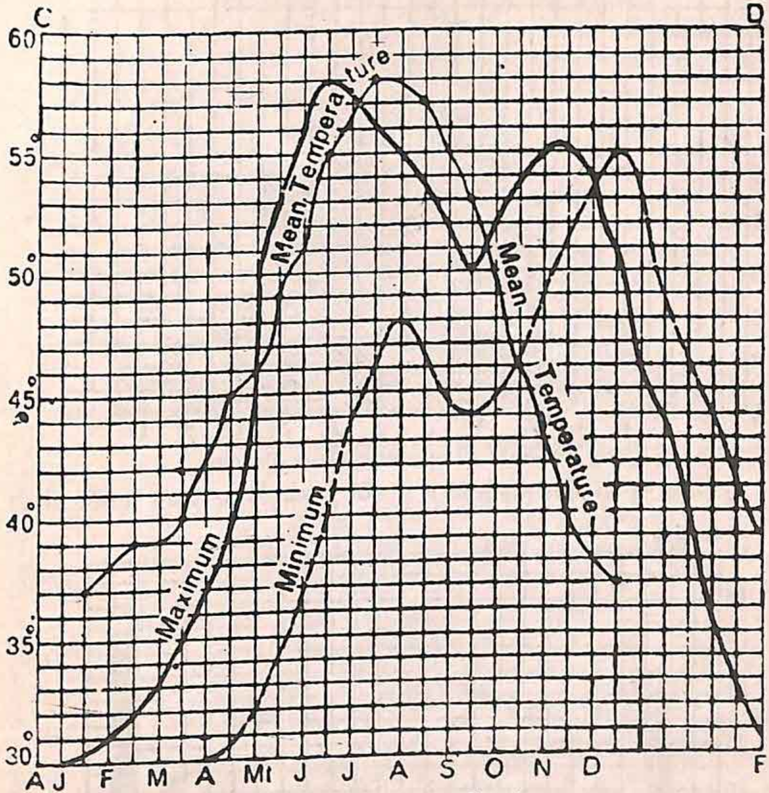


Fig. 52. Temperature Graph

against 39° line. On the line F put a cross against 39° line. In this way number of points are obtained. Join these points and we get a curved line showing the rise and fall of temperature as shown. Sometimes points are not joined together to make a curved line but instead, each point marked on the vertical line is joined with its respective temperature reading to give perpendiculars of varying heights.

The average rainfall distribution is represented by shading which gets darker with the increase in the amount of rainfall. We shall study the merits and demerits of this method in the chapter on distributional maps.

Monthly or Annual rainfall is best shown by vertical bars (Figs. 53 & 54).

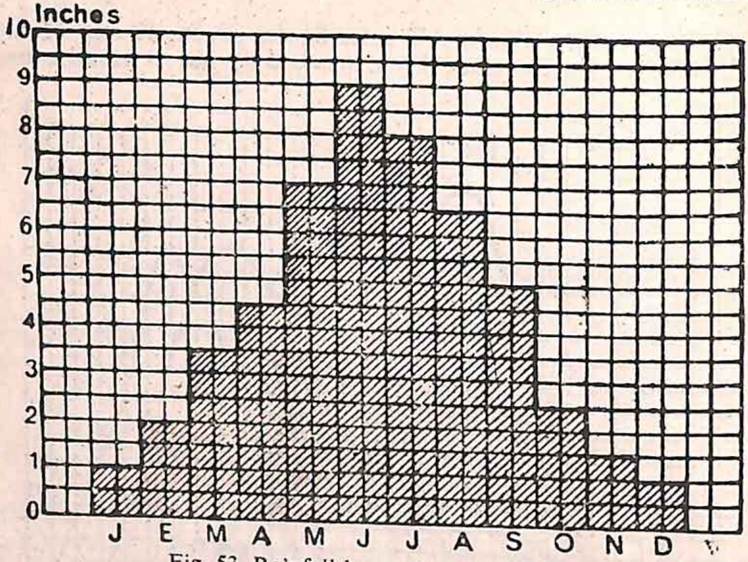


Fig. 53. Rainfall by vertical bars diagram

According to this method it is not possible to draw more than

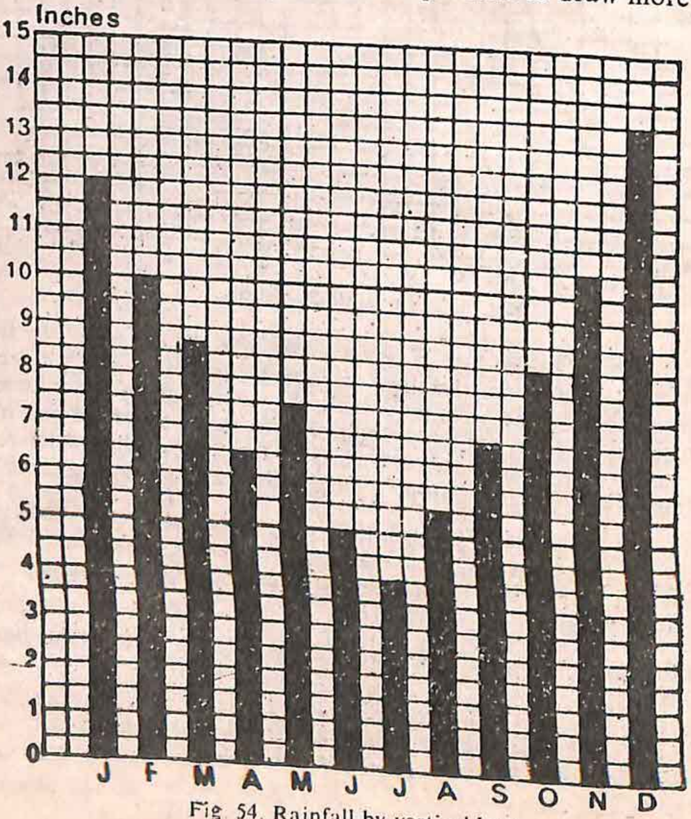


Fig. 54. Rainfall by vertical bars

one diagram for the same place. Hence two diagrams are drawn separately for comparative study. It is a wrong method to show the monthly or annual rainfall by a line graph because unlike temperature, it is not a continuous thing but occurs at intervals.

2. Distributional maps

These maps help in studying the cause and effect, say, of high or of low production of a crop or high and low density of population in an area. When these maps are prepared relief, climatic and soil maps are placed along side. These maps fall into two categories (a) those showing the distribution of stocks and crops or minerals. (b) those showing population. These maps are prepared in the following manner :

Stocks and Crops Maps

(i) *Writing the name of the commodity method*: The area where the particular commodity grows is written in bold letters, as for example Rice, Cotton, Tea, Wheat etc. This method is no quantitative and does not convey any idea about the quantit

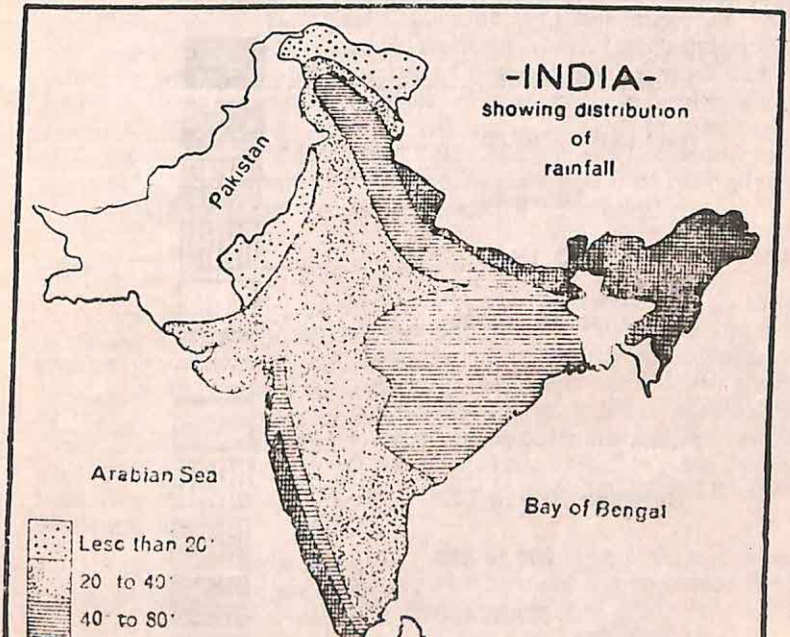
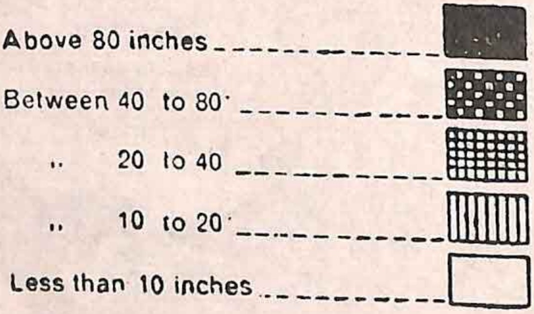


Fig. 55. Map of India showing distribution of rainfall by shading or colour or layer tint method

produced in the area. On the other hand, it does make mention of the crop grown. If for instance, the word "Wheat" is printed in the Eastern Punjab, simply shows that wheat is produced but does not tell us how much wheat is produced per acre in each district. Besides this method does not take into consideration the relief of the area. Because of these inherent defects the method is not much used.

(ii) *Shading or colour or layer tint method*: Here the distribution is shown by different methods of black and white shading or by tints of different colours or different shades of the same colour. The best plan is to use different shades of the same colour to show varying densities. If colours are used, it is safer to employ one colour for a single commodity and employing various shades for its various densities. The easiest and the simplest solution is to use black and white shading. The success of the method depends upon the unit selected which places limits for different shades. The units should be equally spaced and the shades well-graded. To make this point clear, two examples of the units and the shades are given below (Figs. 55 & 56). The greatest defect in this method is that it gives a wrong idea of the uniform production of commodity because it takes into consideration only averages.



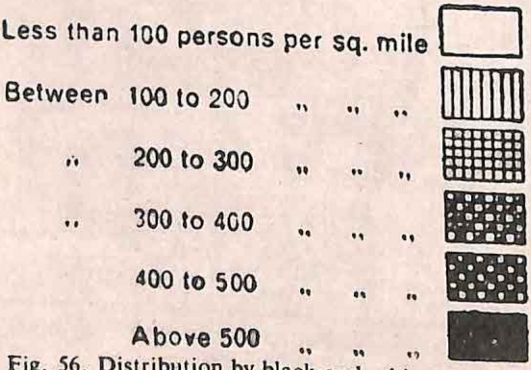


Fig. 56. Distribution by black and white shading

(iii) *The dot method* : In this method a single dot is used to show some fixed amount of the commodity produced. One dot may represent 1000 or 2000 tonnes of any commodity, say, wheat or cotton. The size of the unit to be expressed by each dot is of great importance. It should neither be so small that too many dots may be required to be inserted which will only produce a blurred effect, nor should it be so large as may adversely affect the accuracy of the map. When the scale has been chosen, the number of dots required for each district or province are calculated from the total production given for that district or province. Then the exact number of dots is inserted keeping a relief map and soil map of the area along side. More than half the unit is represented by one full dot, while less than half is ignored. This can happen only in the case of the last dot to be put which represents the degree of mistake in actual calculation.

If the unit to be represented by each dot is well-chosen the dot method can be of great utility in giving absolute figures. Consequently this method is only employed when absolute figures are given. The main idea in placing relief climatic, and soil maps of the area alongside is that we neglect the area where the commodity is not found or we put a lesser number of dots if the quantity found is very small. Similarly, dots can be placed very close in area of large production. Thus the dot method tells us at a casual glance the density of production. One can easily calculate the exact amount of production by counting the number of dots and then multiplying this number with the unit number represented by a single dot.

Population Maps

The population statistics may be of two types: (i) they may show the numbers of persons per unit area, (since these are average figures, the shading or colour method is generally employed); (ii) it may give the actual population in that area. These being absolute figures, the dot method is most commonly adoped. Sometimes the shading and the dot methods are combined so that the same map may give the average and actual figures. The data for the population map are collected from the census return which are prepared by government once in ten years.

Merits and Demerits of Dot Method : Apart from crops and population the dot method may also be used: (1) to locate the exact site of the coal mine in a coal mining area, and (2) to locate sites of fairs, market, factories and towns. The size of the dot will dete mine the importance of the town. There are different forms of dots to be employed for this purpose and therefore any one of these may be used for locating the site. There are certain limitations attached to the population maps. Numbers are varying from time to time. A map made on the basis of a certain year's figures may soon get out of date. Besides, the year selected may be an abnormal one. To overcome this difficulty, these maps may be based on averages.

3. Topographical maps

In these maps the subject to be represented is the relief of land. Relief is the distribution of high and low lands of a country and it is shown by heights and shapes of various hill features. The following methods are employed to show heights :

(a) *Contours* : A contour is an imaginary line drawn on the map joining places of equal height above the sea level. Thus if all points situated 100 feet above mean sea level are joined by a line, then such a line is called a 130 ft. contour. In this way, a number of contour lines are drawn to show the heights and shapes of some hill feature. The vertical distance between any two consecutive contours is known as the Vertical Interval or V.I. For example, if the contours are drawn at 50, 100, 150, and 200 feet apart, the V.I. will be 50 feet. Generally, for a given map this vertical interval is always constant and is always expressed in feet. Thus V.I. is the difference between two consecutive contours.

The horizontal distance between any two successive contours is known as the Horizontal Equivalent or H. E. This Horizontal Equivalent is always stated in yards and it varies all over the map. A small Horizontal Equivalent indicates a steep slope and a long one a gradual slope. A uniform H.E. would mean a uniform slope. These contours assume different shapes to show different relief features. Thus, a mountainous area will be shown by ellipses with increasing heights towards the centre. For a river valley the contours will be V shaped. It requires sufficient amount of practice to recognize the shapes of contours before one is able to interpret from contours the relief features of the land. Similarly, representation of relief features with the help of the contours demands imagination, intelligence and mastery of the various shapes of contours. Contour lines are drawn either with Dumpey Level or Clinometer or with Barometer.

(b) *Hachures*: These are short disconnected lines drawn towards the slope. They follow the direction in which water would flow freely. Like contour lines they are made short and closer for steeper slopes. They do not give the actual heights and this is the main drawback with this method.

(c) *Form Lines* : These are contour lines but broken and also not figured. These too do not show actual heights but only the general relief of the land.

(d) *Hill shading* : This method conveys general idea of the relief of the country and is employed in small scale maps. The hill and mountain sides are shaded darker while plains, plateaus and valleys are shaded light.

(e) *Layer Tints* : In this method tints or layers of colour are used to show the topography of land. Depths, rivers and oceans are shown by blue colour, low lands by green and high lands by brown. This is the most popular method because it is easy and clear cut. This method is most commonly employed in atlas and wall maps.

STATISTICAL DIAGRAMS

In these diagrams figures are changed into readable diagrams. They are of the following types :

(a) *Line graph* : This method is the same as we followed in drawing temperature or pressure graphs. It is based on the fact that one variable changes with reference to the other. One of the two variables is usually the time—days, months or years. This is again illustrated by the figure given below (Fig. 57) which shows the variation in the production of rice in West Bengal over a number of years.

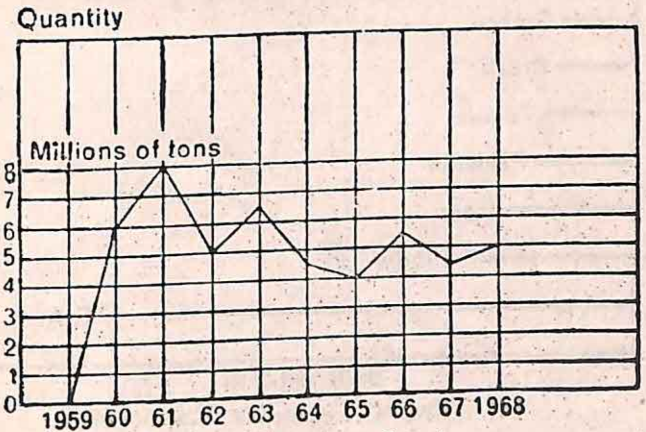


Fig. 57. Line Graph

(b) *Bar Graph* : This is another way of showing variations. Exports of a country may be shown in this way and the export of a

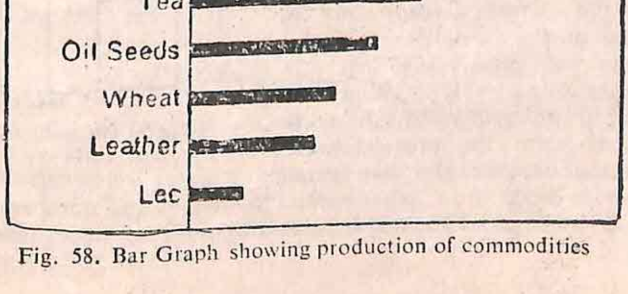


Fig. 58. Bar Graph showing production of commodities

particular commodity from different countries is represented by the figure shown below (Fig. 58). These figures may also be drawn to compare the production of commodity over a number of years or of different commodities in the same year.

They may also be used to show comparative production of a commodity in different countries. Horizontal or vertical bars of equal width but of proportionate lengths are drawn on a graph paper, (Fig. 59)

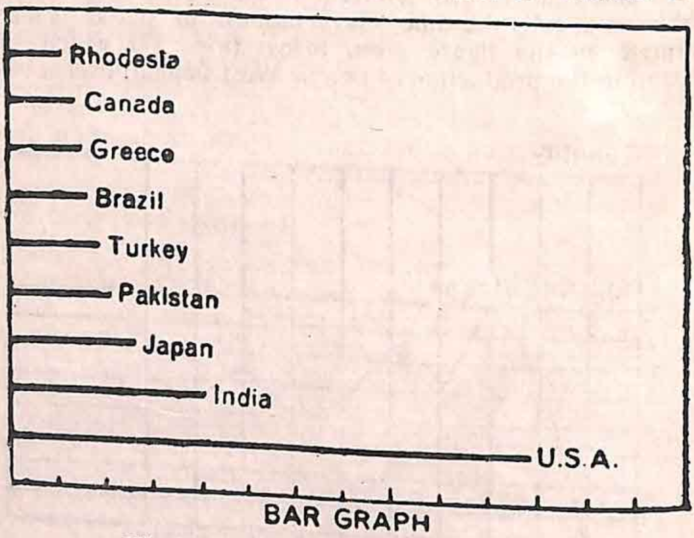


Fig. 59. World Production of Tobacco—1967

(c) *Rectangular diagrams* : According to this method large areas of a continent is sub-divided into smaller areas each of which is represented by a rectangle. (Fig, 60.)

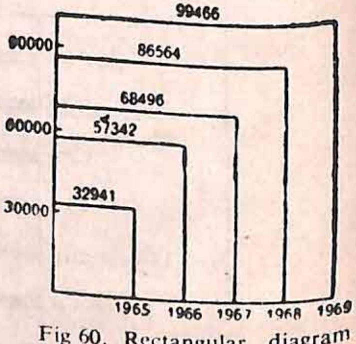


Fig 60. Rectangular diagram showing exports of a country

The area of the sub-region is in proportion to the value it represents. The start is made with the larger division and is arrived at the smaller one by halving it proportionately. It becomes very easy, if it is drawn on a graph paper. Each rectangle contains the proportionate number of squares and one small square on the graph paper corresponds to a round number of units. A modified form of the rectangular diagram may be as shown below (Fig 61)

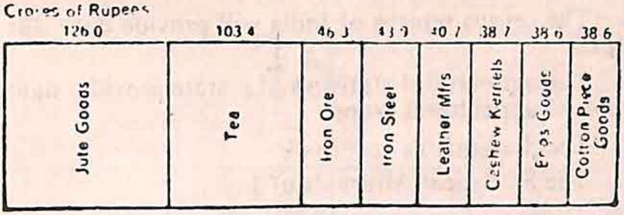


Fig. 61, Rectangular diagram showing INDIA SXPORTS 1968

(d) *Wheel or Circle or Pye diagram* : It is another method of showing comparative distributions. Fig. 62 shows distribution of land and water in the world. The circle denotes the world and each sector represents either the land (continent) or water (ocean). The value of each sector is calculated by a methematical process. A circle has 360 degrees in all and therefore the total world area is made equal to the figure. Since the total area of the world (w) is 360°, therefore each sector will be :

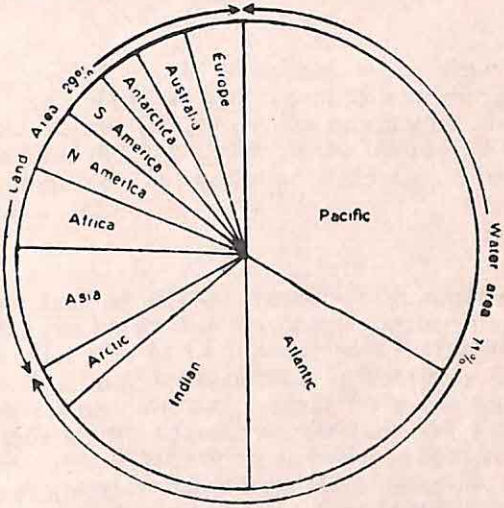


Fig. 62. Wheel diagram showing distribution of land & water

$$= \frac{360^\circ \times \text{area of the sector}}{\text{World area}} = \text{degrees}$$

It should be remembered that the production of each country will be given and we have simply to convert it into degrees. This method gives the average figure only and therefore for actual amounts we have to resort to the dot method which alone gives absolute figures. The following are the chief sources from where geographical data may be collected :

1. The Indian Year Book.
2. The census returns of India will provide data for population maps.
3. The agricultural statistics of a state provides figures for the production of agricultural crops.
4. The Statesman's year book.
5. The Statistical Abstracts of India.

28

Meteorological Instruments And Study of Weather Maps

Meteorology is that branch of science which deals with the phenomenon of the atmosphere with regard to weather and climate. The meteorological instruments include the maximum and minimum thermometers, wet and dry bulb thermometers, barometer (Aneroid), windvane and rain-gauge. Some of the important meteorological instruments are as under :

Thermometer

We are all familiar with the sensation of heat and cold. We can say by touching an object with our hands whether it is hot or cold, but we cannot say how hot a substance is at a certain time. This degree of heat is called temperature. A hot body is said to be running high temperature and a cold body low temperature. When a man is suffering from fever, we generally say that he has got temperature. This difference is in evidence both horizontally and vertically. Temperature varies from place to place depending upon various factors. Air gets heated after getting in touch with hot bodies and not directly by the rays of the sun. The temperature is measured by an instrument called Thermometer.

Generally a thermometer consists of long and narrow glass tube and a small bulb. The bulb invariably contains mercury. The stem or the frame which supports it is graduated.

Three scales of a thermometer

Place an ungraduated thermometer in a beaker of ice and water. The mercury level will stand at its lowest level known as the freezing point. Now place the same thermometer in the steam of boiling water. The mercury level will rise from the bulb into the stem and will stop after reaching the highest point. This is called boiling point. When these fixed points are marked on the thermometer, the space in between the two fixed points is divided into equal number of parts. It is done in three different ways. If the lowest point is marked 0 and the upper fixed as 100 and the space is divided into 100 equal parts, the thermometer is known as a Centigrade

Thermometer. If the space is divided into 80 equal parts and the lower point marked as 0 and the upper as 80 we get the Reaumer Thermometer. If, on the other hand, the space is divided into 180 equal parts and the lower fixed point is marked 32 and the upper

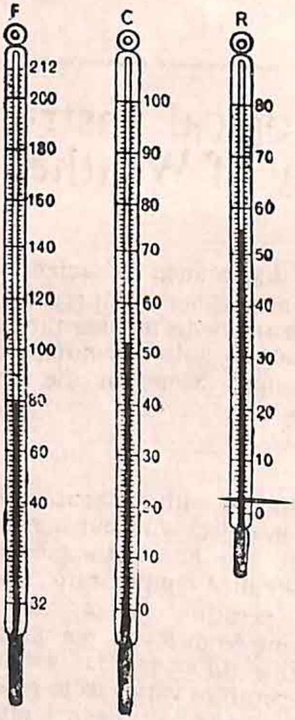


Fig. 63 Three kinds of Thermometers

212 we get the Fahrenheit Thermometer (Fig. 63). Thus temperature may be measured with the help of a Centigrade or a Fahrenheit or a Reaumer Thermometer and will then be written as C, F or R respectively as the case may be. In India Centigrade and Fahrenheit thermometers are used and in Germany the Reaumer.

OTHER KINDS OF THERMOMETERS

Maximum and minimum thermometers

Suppose we wish to know the highest and the lowest temperatures for the day. It would be very troublesome to watch the thermometer every hour in order to note the highest or the lowest temperature reached. Even if this practice is followed the figure arrived at will not be very accurate. Thus there exists a thermometer known as Six's Self-Registering Maximum and Minimum thermometer

(Fig. 64) This will record automatically the highest and the lowest temperatures for a given period of time.

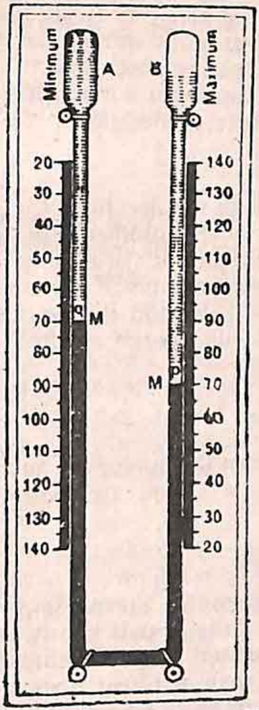


Fig. 64. Maximum and Minimum Termometer

It consists of a U shaped tube containing mercury. The bulb A and part of the stem upto M is filled with alcohol. The bulb B and part of the stem upto the mark M contains alcohol. Part of the bulb B is left unfilled to give space for expansion. When the temperature rises, the alcohol in A expands, the end M of the mercury column falls, end M′ rises and pushes the index p ahead. When the temperature falls, the alcohol in the bulb A contracts, the end M′ of the mercury falls and the end M rises and pushes forward the index q. Thus the position of the lower edge of the index p indicates the highest temperature and that of q the lowest temperature reached during a given time. The indices are provided with steel springs, which do not allow them to move up and down by themselves. In order to set the thermometer, the indices are pushed down to the level of the mercury column with the help of a magnet.

Maximum and minimum temperature

The highest temperature reached during the day is called the maximum temperature and the lowest temperature reached during the day is called minimum temperature.

Mean temperature

The mean temperature of a day is obtained by adding together all the temperature readings made during the day and dividing the sum by the number of times the observations are made. The average of the maximum and minimum temperature for a day is also very nearly the mean temperature of the day.

Mean annual temperature

If we add all the mean temperatures for each day of the month and then divide the sum by the number of days in a month, the result will be the average temperature of the month. If we divide by 12 the sum of the mean temperatures of 12 months we get the average temperature for the year. If we add the average temperatures of 5 or more years and divide the sum by the number of years we get the mean annual temperature.

Daily range of temperature

The difference between the maximum and minimum temperature of the day and the night is called the daily or diurnal range of temperature.

Annual range of temperature

The difference between the mean temperature of the hottest and the coldest months of the year is known as the annual range of temperature. A small annual range indicates the equable or maritime climate as that of Japan or Great Britain. Where this range is great, the climate is said to be one of extremes or continental, e.g. in Tropical countries like India.

Temperature curve

The variations in temperature for a given period is expressed by means of a curve drawn on a graph paper. In this way one need not look into the figures and will come to know at a glance the rise and fall of the temperature.

Isotherm

There are certain places on the earth's surface having the same temperature. A line joining these places of equal temperature is called an isothermal line or an isotherm. (iso=equal, therm=heat).

Pressure of the air

Air has weight. To prove it, take a football bladder and weigh it. Fill it with air and reweigh it. The difference in the two weights will give you the weight of the air contained in it. This air which has got weight of its own is easily compressed. It expands when the pressure on it is decreased. The earth is surrounded by a stratum of air many miles deep. Air becomes thinner as we ascend. This air, because of its weight, exerts pressure on the surface of the earth. Pressure varies from place to place. The pressure at sea level on the average is 15 pounds to every square inch but this pressure decreases at the rate of 1 lb after 900 feet of ascent. On an average one cubic foot weighs 1¼ ounces.

Measurement of atmospheric pressure

We measure the pressure of air by an instrument known as Barometer (baro means pressure and meter is, what measures). The simplest form of a barometer consists of a graduated glass tube 36″ long closed at one end and open at the other (Fig. 65). It is filled completely with mercury and is then inverted in a cup containing mercury. When the tube is held in a vertical position some of the mercury flows down into the cup and will stand at a height of 30″. However the size, shape, height or form of the tube may change, the height of the mercury column is always the same in the tube, i.e., 30 inches or 76 cms.

By the term 30″ pressure of air we mean the weight of the mercury which stands at a height of 30 inches in a tube of 1 square inch in cross-section. Thus the pressure of the atmosphere is equal to the weight of the mercury column, 1 square inch in cross-section and 30 inches in height. The pressure may also be measured in centimeters. The unit of weather maps is the bar which is divided into one thousand milibars. One bar is equal to a barometer reading of 29.53 inches. The barometer (at sea level) rarely falls below 28 inches (950 milibars) and rises above 31 inches (1050 milibars).

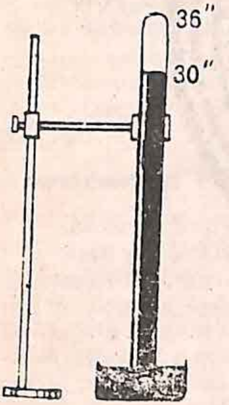


Fig. 65. Tube Barometer

Aneroid Barometer

A barometer described above is not portable and therefore, cannot be carried from place to place. There are many other kinds of barometers, e.g. Siphon barometer or Fortin's barometer and Aneroid barometer. Of all these, Aneroid barometer is the best. It is very convenient, accurate and portable. It consists of a metallic box with a flexible lid (Fig. 66). The box is partially exhausted of its air so that the lid may buldge in or out with the increase or decrease of external pressure. The box is connected with a spring which in turn is attached to the base of the barometer plate. A thin rod is attached to the spring and any movement of the lid is transmitted through the spring to the rod, which moves on the plate and thus enables one to read it.

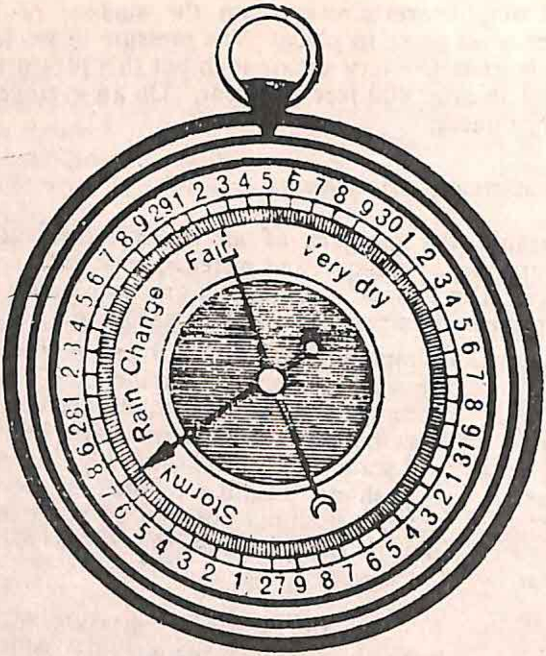


Fig. 66. Aneroid Barometer

Barograph

The meteorologist records these variations in pressure by an instrument known as barograph, based on the principle of aneroid barometer. This instrument records automatically the changes in pressure.

Pressure curve

The readings from the barograph are expressed in the form of curves drawn on graph papers as in the case of temperature curves.

Isobars

Isobars are lines which join places of equal pressure (iso= equal, and bar means pressure). The meteorologist from these readings forecasts weather based on the following principles :

1. A rising barometer (high pressure) indicates fair weather.
2. Rapidly falling barometer indicates an approach of rain or storm.
3. Continued high barometer indicates fair weather.

Causes of Rainfall

Evaporation is always taking place on the surface of oceans, seas, lakes, rivers and ponds. It is natural then, that the atmosphere contains water vapour. This amount of water vapour in the atmosphere may vary from time to time at the same place and from place to place at the same time. When air laden with moisture rises, it is cooled because of coming in contact with colder air masses above and because of expansion due to reduced pressure. When the air cools it can no longer hold all the water vapour it previously held. Therefore condensation takes place round some dust particles and forms clouds. Thus clouds may be defined as particles of water floating in the air. When these clouds have to rise still more in upper regions. the smaller particles of water continue to form bigger drops which become so heavy that they cannot be supported by air. Then they begin to fall as drops of rain. Thus cooling of the saturated air is the primary cause of rainfall. Air is said to be saturated when it cannot hold any more moisture at a given temperature.

Measurement of Rainfall

In order to measure the exact amount of rain water which falls at a place we generally use an instrument known as the rain-gauge. It consists of a metallic cylinder in which is fitted a metallic funnel which permits raindrops to pass through it to be collected in a bottle, in the neck of which is fitted the lower end of the funnel. When the rain has taken place the collecting vessel is taken out and the water is poured in a graduated cylinder known as measuring vessel. The measuring cylinder is so graduated as to give the amount of rainfall in inches by direct reading. Thus rainfall is measured in inches. When the water in the measuring vessel stands at the mark of 50 it is equal to ½" rainfall (Refer to Fig. 40).

One inch of rainfall

When we say that one inch of rainfall has taken place, it means that the depth of the rain water, if collected on the surface of the earth, will be equal to one inch.

Rainfall Chart

The thermometer and the barometer change continuously so that we can express sharp changes by a continuous line known as curve line. But rainfall is not continuous and occurs at intervals and therefore, should not be represented by a continuous line. Instead of drawing a line we draw little shaded rectangles or blocks.

Isohyet

Isohyets are lines joining places having equal rainfall.

Every country has a Meteorological department of its own. The purpose is to maintain daily and other records of the weather conditions, to forecast weather, and to publish daily and other weather reports, charts and maps. The Indian Meteorological department was founded in 1875 and has its headquarters at New Delhi. This department maintains a number of observation stations all over the country. Each of these stations sends its weather reports once or twice a day to the head office. The observations are made at 8 hours, which time is fixed internationally. When the observation time approaches, the observer goes out and makes the following observations with the help of the instrument noted against each. When readings are made they are noted down in a weather map and a copy is sent to the Head Office. At the same time ships in the Indian Ocean record their observations and send them to the Head Office.

1. *Pressure*: It is measured by a self-registering barometer known as Barograph and is expressed in the form of isobars.

2. *Winds* : The direction and speed of winds are measured by instruments known as Wind-vane and Anemometer respectively. The direction of winds is expressed by means of certain notations.

3. *State of the sea and sky* : This is again put in weather reports in the form of symbols.

4. *Temperature* : It is recorded by a self-registering thermometer known as Thermograph which contains both the maximum and minimum thermometers. Temperature is shown by means of isotherms.

5. *Sunshine* : It is recorded by an instrument called Sunshine recorder. It is a sphere made of crown glass 4" in diameter and 3 lbs. in weight supported on a basement made of metal. It is fixed in such a position that the sun shines on it throughout the time it is above the horizon. A graduated card is placed in the groove behind the ball. The card is charred at the points where image of the sun falls. This card is replaced after sunset.

6. *Rainfall* : A rain gauge measures the amount of rainfall that takes place during 24 hours.

7. *Moisture in the atmosphere* : This is measured by a thermometer known as Wet and Dry Bulb Thermometer. It consists of two similar thermometers fixed on a frame side by side. The bulb of one is covered with muslin and the other end is dipped in a beaker containing water. The temperature of the wet bulb thermometer is always lower than that of the other. Readings are taken from the two thermometers simultaneously. The difference of the two gives the saturated or unsaturated state of atmosphere.

The Indian daily weather report

The Indian Meteorological Department publishes an Indian daily report. This weather map gives a summary of the conditions over a large area and is based upon observations made at a number of stations and collected together at the central office. Such a map can be had from the office of the Director General of Observations.

On the first page of the weather report is entered a summary of the observations made at 8 hours. Weather forecast for next 24 hours is also given therein. The fourth page has got three maps, one showing pressure, winds and rainfall conditions for that day at 8 hours. The second map shows the pressure departure at 8 a.m. from the normal and on the last is expressed, the departure of mean temperature of the day from the normal. The second and third pages contain certain statistical figures. Another map showing the weather conditions of the previous day is also added. A study of weather maps for a year can give an idea of the climate of India.

PART IV

LESSON PLAN AND NOTES OF LESSONS

29

The Plan of Geography Lesson

Young beginning teachers are likely to think that teaching is to inject ideas into the minds of the pupils as medicine is injected into the body of a sick man. But teaching is a process by which the mind is made to react to external conditions. This reaction is, however modified by the stock of existing experiences. No two minds respond identically to the same situations, nor a single mind reacts identically in two similar situations. A teacher should not expect his pupils to respond to a situation in the same manner as he would respond. All ideas presented to a learner require digestion and assimilation before becoming a stock of his knowledge. The senior students have developed sufficient skill and a store of knowledge to be applied to meet complex situations. Beginners are, however, not prepared to accept new complex ideas though they are able to stuff themselves with new ideas by cramming to be poured at the time of examination and then to forget. In a geography lesson it is recommended that pupils should take an active part in it. This is possible only if the teacher is careful enough to lead them to draw inferences from the facts put forward and to verify facts for themselves with the help of a map, a diagram or statistical data. Home task is an important part of an oral lesson and, therefore, should be given due weight.

The main duty of the teacher in giving an oral lesson is to act as a stimulant and a guide. Consequently, the teacher should follow the regional method and the comparative method. He may employ the logical order or the psychological order to suit the subject matter. To add interest to his lesson, the teacher may quote examples of recent developments occurring in different parts of the world. It is most desirable that the teacher's knowledge should be kept most up-to-date by a constant reference to newspapers and magazines.

To add variety to the deductive method of giving a lesson, a vivid description of places and peoples is very essential. These descriptive passages are available in the books on travel, periodicals, articles and illustrated magazines. But a word of caution may be given. The descriptive passage should not be too long. These descriptions become more interesting and lively if they are accompanied by pictures and maps projected by an epidiascope. This illustrative material should be well-chosen. The teacher must make a good use of the black-board during the progress of lesson for drawing diagrams and writing summaries.

The sectional recapitulation is necessary to make the lesson effective. The teacher should not be satisfied merely with his oral instructions. Pupils are likely to forget or misunderstand what they listen to. Therefore, revision consisting of oral questions and answers becomes essential. The questions should be thought-provoking and to the point. Elliptical questions may be sparingly used. Reasons of failure to answer correctly must be investigated. The defect may either be with the teacher or with the taught. A wise teacher will at once withdraw the defective questions and put new ones. Thus a geography lesson, like a lesson in any other subject, may consist of the following steps :

1. Motivation

At the beginning of the century pupils used to work in order to escape the pain of rod or cane. The reform movement devised various procedures for holding attention of the pupils. A person's behaviour depends upon his response to his urge that he feels within himself. This is known as Motivation. Motivation comes from within and not from outside. To motivate his pupils the teacher should know the immediate needs of his pupils so that he can visualize situations in which the pupils would respond the most. Some needs of adolescents are so common that a wise teacher can easily anticipate them. Thus motivation is the manifestation of a need.

2. Introduction

Learning is composed of association of mental images on "concepts", as these are called. The images mostly arise from real situations but may also be derived by imagination. In geography as in any other science subject, learning comes through association of experiences and imagination of new images. Geography teaching makes use of various types of experiences which are recalled during the process of teaching. First hand experiences are basic experiences but vicarious experiences which are mostly used in school teachings need careful treatment because their effectiveness depends upon the pupils' store of knowledge. The general purpose of the first step is to prepare the pupil's mind for the new knowledge. The introductory stop will have its purpose fulfilled when it has brought to surface the existing store of ideas, which may form an appropriate point of departure. The general plan is to put one or two relevant questions on the previous topic related to the lesson in hand. Sometimes, when the topic is a new one, a map or a picture or actual presentation of the object may form a very good introduction. Before entering upon the next step, the aim of the lesson should be made clear. In a geographical topic, it consists of a line of statement bringing out clearly the subject of the new lesson. The aim of the study should be as clear as possible.

3. Presentation

Ideas form the raw material for higher thinking process and are a means to an end. Ideas are of three kinds, some are essential, some are desirable and the remaining are interesting. Learning process constitutes laying emphasis on different types of ideas as all the three types are not of equal value. Desirable ideas are those, which the pupils are expected to have, the essential ideas are those which the pupils are expected to recall. The mastery of the essential ideas have to be gained by the exercise of mind and brain. Most of the learning is achieved through the media of words. Verbalisation without understanding is meaningless. It is of no use to memorize meaningless statements. Therefore, in geography teaching it is better to aim at understanding than at vocabulary. In other words, it means to secure a child an adequate stock of experiences as a background. Once this is achieved, the children are in a position to struggle themselves for new vocabulary. In this step the teacher proceeds to attack the new matter. The whole subject matter to be presented is subdivided into sub-sections, each one leading logically to the next. Another point worth-noting is that each sub-section should have the whole attention centred upon it and afterwards it should be re-examined with that what has gone before. That procedure is called the law of alternate absorption and reflection. For instance, at one time pupils will concentrate upon the plateau of the Deccan and at an other time they will study it in relation to the rest of India.

4. Comparison and contrast

This forms an essential part in a geography lesson and consists of such comparison and contrast as the pupils are able to do for themselves. Two precautionary measures must be adopted. In the first place, the things compared must be thoroughly known. Secondly, only those comparisons should be made which are useful in that they set the students to think. The new impressions gained by pupils need time for consolidation and for fitting in the stock of knowledge. Text-books, note books, charts and models and other audio-visual aids are useful devices to help and expedite the process of summarisation. To give variety in the types of summary, these devices should be alternately used during the course of a lesson.

5. Application

Knowledge in itself is only a half-way house. Only that knowledge is of real value, which the pupil can put to some kind of use, hence the importance of application of knowledge. When a formula has been deduced, it must be applied to enable the child to understand it well. The application step may have a great variety. It may be applied by making a map or a model or the pupil may apply the geographical ideas in the description of an imaginary journey. Forgetfulness is the cause of memory. Some forgetting is inevitable, but the extent depends upon the strength of original impressions, images and associations. Forgetting is bound to occur with the passage of time unless repetitions are done at frequent intervals. Therefore, review and drill are most essential when learning is to be done at mastery level. Drill means creation of a question-response activity. The best way to review a situation is to repeat it and to do it in the actual form.

Lesson Plan

Lesson planning is the key to successful teaching. A teacher should be prepared to anticipate pupils' difficulties and reactions. Lack of planning will create disciplinary problems. The effectiveness of a geography lesson is judged by the pupils' reaction to the material presented. It is essential to plan a lesson because it saves time and reduces fatigue. Each lesson plan should be prepared according to the need of a particular situation. In a lesson there should be provision for the introduction of new material, organisation of information, summarisation and recapitulation. It is good to introduce new lesson with reference to some activity of the previous one in order to prepare the minds of the pupils for the new lesson. This may involve the use of an oral questioning, short written test, etc. as the situation demands. Most of the lessons are ended with summary to create impression on the pupils that a certain topic has been covered. Verbal summaries are not always effective and should not be a permanent feature of a geography lesson. New material can be introduced through direct or vicarious experience or both. The presentation of new material should be intercepted at intervals by activities that will help pupils to assimilate the new material. The development of the lesson should be very smooth. The new teachers have to be very careful in this respect because the experienced school teachers have learnt, by trial and error, the steps that succeed and those that fail. A good lesson plan gives the teacher a sense of security and confidence.

It may be useful to study a few lesson plans given in this part of the book to show how the various steps discussed above have been made use of. These lesson plans are both for formal situations as well as for informal situations. In these lessons, there is sufficient scope for variation in the types of activities. In these lessons it has been taken care that matter and method go hand in hand. The lessons have been so planned as to provide opportunities for the pupils to exercise initiative.

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Lesson on Mexico

Subject	Geography
Topic	Mexico
Class	VIII
Time	40 minutes.
Average	13 years.

Apparatus : Ordinary requisites of a class room, coloured chalks, a map stand, a political and a physical map of Mexico or North America.

Aim : (1) To explain the influence of physical factors namely, situation, relief, features and minerals in Mexico on the progress of mankind, (2) To broaden the outlook of pupils by giving them new facts.

Previous knowledge : Pupils have already studied North America, Canada, and U.S.A. in outline.

Introduction : Today's topic will be introduced by referring to the political divisions of north America.

Name the countries included in the Continent of North America (Canada, U.S.A., Mexico, New Foundland, Alaska and Central America).

Some pupils will be asked to point out on the map the boundaries of Mexico. Then the teacher will make an announcement of to-day's topic, "we shall study to-day the geography of Mexico."

Presentation : The whole matter to be studied is divided into the following units to facilitate assimilation :

UNIT 1. POSITION AND TOPOGRAPHY OF MEXICO

Matter	*Method*
Mexico is situated to the south of U.S.A. and consists of	A physical map of North America will be presented and

Matter	*Method*
a broad high plateau; a prolongation of the Rocky móuntain plateau of U.S.A.	pupils will be asked to show the boundaries of Mexico.
The plateau is broad in the North and tapers towards the south. There is a narrow coastal plain on either side of the plateau.	Great diversity in the topography of Mexico will be emphasized with reference to tints of colours employed therein.
On the west is the long mountainous peninsula of lower California. Similarly Yukaton lies towards the south east.	Here again, use will be made of the political and physical maps of North America to show the position of the peninsula. In order to know their grasp of the matter, the teacher will put the following questions : Divide Mexico into its physical divisions (three divisions) : (a) ~~C~~oastal plain. (b) Slopes of the hills. (e) Plateau. While the pupil is answering, the teacher will prepare on the blackboard with coloured chalks an outline map of Mexico showing the three divisions as shown below (Fig. 67).

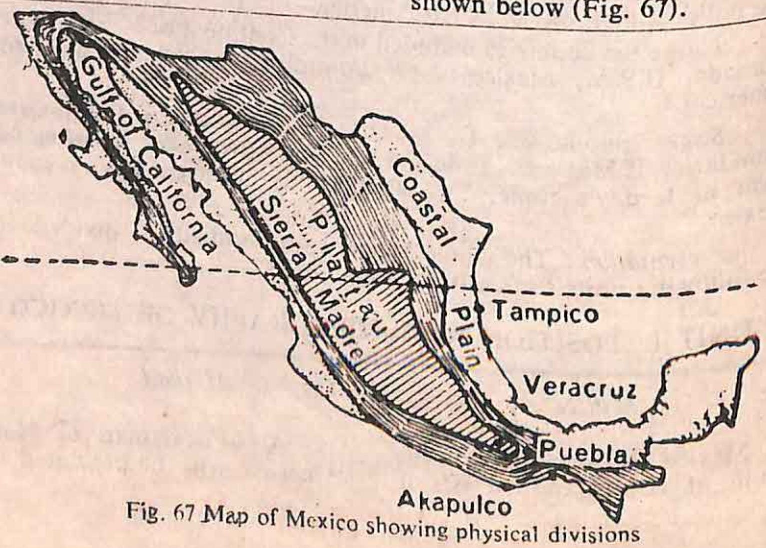

Fig. 67 Map of Mexico showing physical divisions

Unit II. THE STUDY OF CLIMATE AND ITS BEARING ON MAN AND HIS ACTIVITIES

(a) Climate

Matter	*Method*
The Tropic of Cancer divides Mexico into two parts. Thereforce, it has got the tropical climate. The coastal plains are hot and attract heavy rainfall. The flanks of the plateau are cooler and attract a good amount of rainfall. The plateau itself is cut off from the influence of the sea. The weather in general consists of hot days and cold nights. The annual range is very great. The rainfall on the slopes and the plateau is due to monsoonal effect. Plateau gets heated in summer and attracts winds from the sea. Lower California is a desert being situated in the rain shadow area.	The influence of the Tropic of Cancer will be added by means of the following questions. 1. Locate the Tropic of Cancer on the map of Mexico. 2. What is the climate of place having Tropic of Cancer passing through it ? The rainy nature of coastal plains and slopes will be adduced from the pupils by making recourse to their previous knowledge. 1. What winds blow in the tropical areas ? (trade winds) 2. What is the direction of these winds in the northern hemisphere ? (N.E.) 3. Will these winds bring rain ? (they are generally dry but pick up moisture during their passage over the sea.) 4. What are monsoons and how they are caused ? 5. How does the plateau get rainfall due to monsoons ? The dryness of lower California will also be adduced. 1. What is rain shadow area ? 2. How do you account for the dryness of lower California ?

(b) Man and his activities

Matter	*Method*
The density of population in Mexico is very low. Coastal plains are thinly populated due to unhealthy conditions of the	This low density of population will be explained as well as adduced by putting the following questions :

Matter

climate while the plateau has comparatively thick population. Man cultivates such tropical crops as sugarcane, tobacco and rubber on the coasts. Coffee and maize are grown on cooler and lesser rainy slopes of the plateau. But wheat, cotton and maize are cultivated under irrigation.

Method

1. Why are the equatorial lands thickly populated ? (because of hot and moist climate.)
2. Why are the coastal plains sparsely populated ?

The cultivation of tropical crops and the necessity of irrigation will again be adduced by the following developing questions:

1. What is the summer agricultural produce of India ? (Cotton, Rice, Tobacco, Tea etc).
2. Describe the climate required for their growth (Hot and moist).
3. What can be the agriculture of Mexico then ?

The control of the physical factors of the country on the activities of man will, particularly, be emphasized.

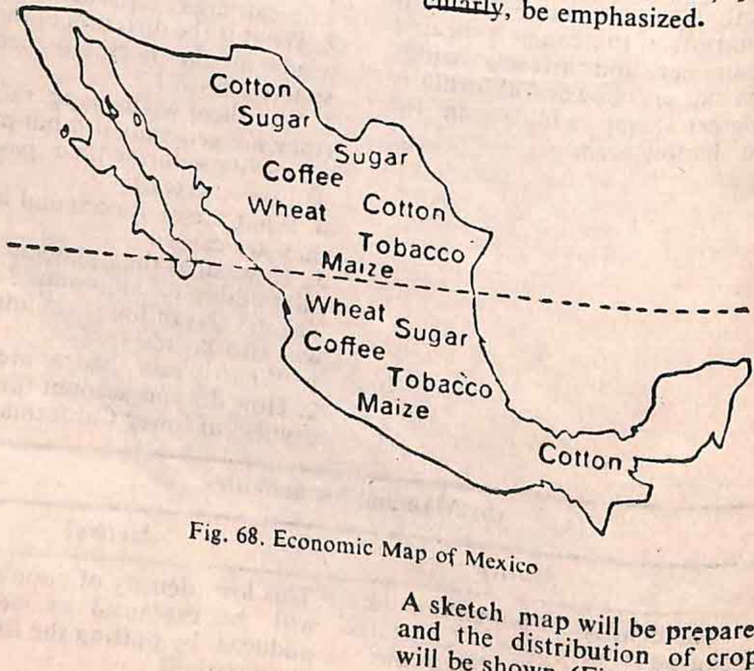

Fig. 68. Economic Map of Mexico

A sketch map will be prepared and the distribution of crops will be shown (Fig. 68). Before proceeding to the next step the teacher will put the following

Matter	Method
	questions to make the lesson effective : 1. Why does the plateau receive lesser rainfall than the coastal plains of Mexico ? 2. Name some of the agricultural crops of Mexico and locate their causes of growth.

Unit III. MINERAL WEALTH OF MEXICO, ITS INDUSTRIES, TOWNS AND PORTS

Matter	Method
Silver, copper and oil are found in great abundance. To make up the deficiency of coal and iron, which are also found in small quantities, hydro-electric power is generated on the plateau. These minerals are found because of the rocky nature of the plateau. Following are some of the important towns of Mexico. There are mineral towns like Mexico and Peobla, oil ports of Vera Cruz, Akapulko and Tampico. Mexico has not developed a large number of industries because of lack of initiative of the inhabitants.	The richness of the mineral wealth will be told and their causes be traced and then distribution will be located on the map. Where minerals are found in Maxico ? The position of the towns and ports will be shown on the political map of Mexico and the importance of each will be told. Then sketch map of Mexico will be prepared and the distribution of minerals and towns will be inserted. After this, sectional recapitulation for this step will follow : 1. Locate the importance of the following towns :
As compared to U.S.A. and Canada, this country is very backward. This is due to relief and climate and unsettled political conditions. Mexico has undergone many revolutions within the last one hundred years.	Mexico, Vera Cruz, Peobla, Akapulko and Tampico. 2. Fill in these towns in the sketch map of Mexico. 3. How do you account for the deficiency of industries in Mexico ? Pupils will be led to realise how the political disturbances and the environmental conditions of climate and relief have all left Mexico a lesser progressive country than Canada and U.S.A.

Recapitulation

The following thought-provoking question will be asked :

1. Divide Mexico into natural divisions.
2. What do you know about the mineral Wealth of Mexico?
3. Where are the following and why are they famous ?
   Mexico, Peobla. Vera Cruz and Tampico ?
4. Mexico is a developing country, how ?

Application : The following questions will be set for home task :

Write a geographical account of Mexico. Illustrate your answer with maps.

Black Board Summary : The blackboard summary will be developed as the lesson proceeds.

(i) Physical division of Mexico.

(a) Coastal plains.

(b) Hill slopes.

(c) Plateau.

Climate : Coasts are hot and moist, slopes are cool and rainy and plateau is cool and dry.

(iii) *Agriculture* : Sugar, tobacco, rubber, maize and coffee are cultivated on slopes, wheat and maize on mountain tops.

(iv) *Mineral Wealth* : Silver, copper, gold, coal, and iron are found in Mexico, oil in Tampico and cotton goods are manufactured in Vera Cruz.

(v) Backwardness of the country is due to :

(a) Unsettled political conditions.

(b) Relief features.

(c) Tropical climate.

31

Lesson on Rainfall of India

Class	IX
Subject	Geography.
Topic	Rainfall of India.
Time	40 minutes.
Average Age	14 years.

Apparatus : Usual class room apparatus, a climatic or rainfall map of India, an outline sketch map of India on the blackboard, two sketch maps of India showing summer and winter rainfall conditions respectively. A relief map of India showing the direction of winds and distribution of pressure, a pointer and some coloured chalk.

Aim : (i) To acquaint pupils with the distribution and extent of summer and winter Monsoons of India. (ii) To broaden their vision and outlook by giving them new information.

Previous Knowledge : Pupils have read the surface features and they know what are periodical winds, i.e. Monsoons.

Introduction : The teacher will put the following question to test the previous knowledge of the pupils and also to link the new lesson with the old one.

What are Monsoons ?

Announcement of the Aim : The teacher will announce to the class : "To-day we shall find out the causes and distribution of rainfall in India in summer as well as in winter."

Presentation : The whole topic will be divided into the following two units :—

(A) Summer Monsoons.

(B) Winter Monsoons.

(A) Summer Monsoon

Unit 1, Bay of Bengal Branch : The teacher will start the lesson by referring to the tropical situation of the country. He will show on the map the presence of the Tropic of Cancer through the heart of the country. He will try to adduce from pupils the south-west direction of the summer monsoons. After this the teacher will tackle the following branches of Summer Monsoons of the Bay of Bengal :

(a) The comparative distribution of high and low pressure on the Ganges delta and Bay of Bengal will be referred to explain the blow of winds arising from Bay of Bengal which rise up the Khasi, Garo and Jantia hills. (The position of these hills will be located by the pupils on the map). It will be emphasized that Cherrapunji situated in this area, gets the heaviest rainfall in the world.

(b) Another branch of the Bay of Bengal Monsoon that rises up the Himalayas will be located and explained and the effect of relief on the control of the direction of these Monsoons which blow westward up the Ganges valley will be adduced from pupils by locating the presence of Himalayas on the north and smaller hills on the east.

Pupils will be led to conclude that these monsoons get drier and cause lesser rainfall as they go towards the west. This point will be emphasized by examples, that Calcutta receives 50″ rainfall, Varanasi 30″ and Delhi 20″.

The direction and movement of these winds as determined by

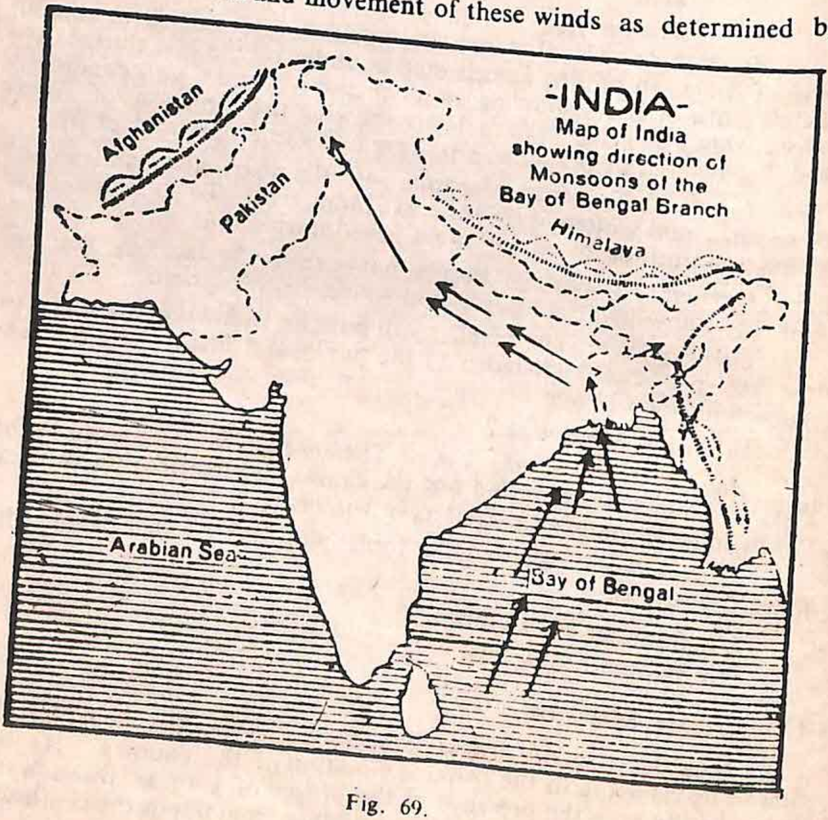

Fig. 69.

the relief features of India will be explained by relief and rainfall map as shown in (figure 69).

Sectional Recapitulation : Why does Delhi receive lower rainfall than Calcutta ?

Unit II. Arabian Sea Branch : In this step the three branches of the Monsoons will be taught.

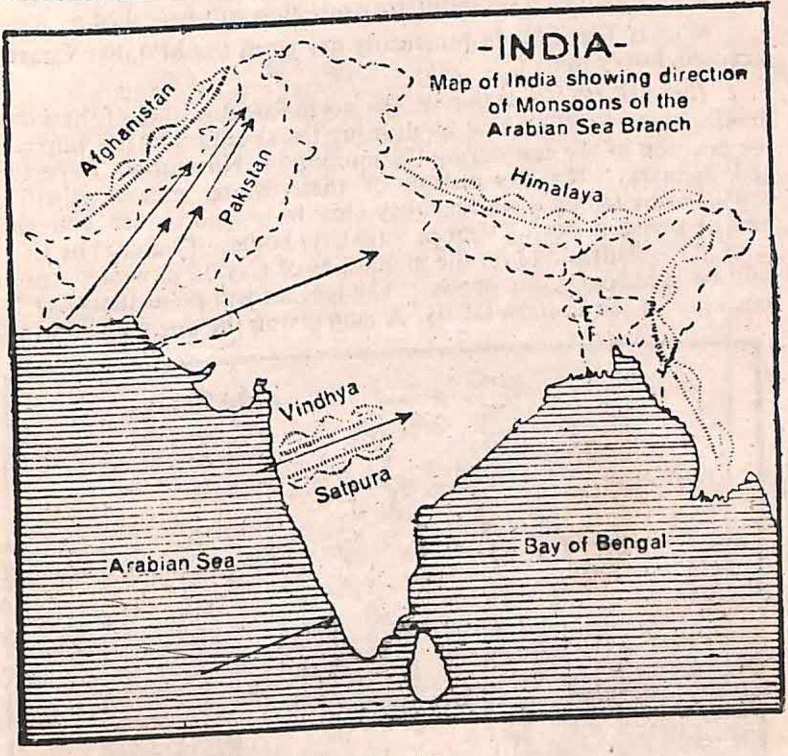

Fig. 70.

(a) *Western Ghat Branch* : To emphasize the effect of relief on India and the part played by the western ghats will be adduced. After crossing ghats, winds become dry and give about 20″ of rainfall to the table-land of Deccan. In Tamil Nadu there occurs only 15″ of rainfall.

(b) *Narbada Valley Branch* : The Satpura and Vindhya mountains afford a free passage to the Arabian Sea Monsoons which shed heavy rainfall in Chota Nagpur by rising up Rajmahal and Chota Nagpur hills. The parallel position of these hills will be shown on the relief map of India and will be drawn by the teacher as well as by pupils on the black-board.

(c) The dryness of Rajasthan and Sind (Pakistan) will be adduced from pupils who will be told that the Aravalli hills lie parallel to the direction of monsoons. These winds give heavy rainfall when they rise up the Punjab hills. Here again, the direction of the Arabian Sea monsoons will be shown on the relief map of India by the teacher as shown in Fig. 70.

Sectional Recapitulation : In order to revise what they have studied, the following recapitulatory question will be asked :

Why is Tamil Nadu practically dry when the Malabar Coast is receiving heavy rains ?

Unit III. Winter Monsoon: The north east direction of the winter monsoon will be illustrated by drawing the attention of the pupils to the position of the sun during the months of November, December and January. The dry nature of these winter monsoons will be explained by telling them that they blow from land to sea and they pick up moisture during their passage over bodies of water. The heavy rainfall in Madras and on the mountains of Ceylon in winter season will be adduced from pupils. The teacher will point them out the existence of the Eastern Ghats. A map giving the direction of winter

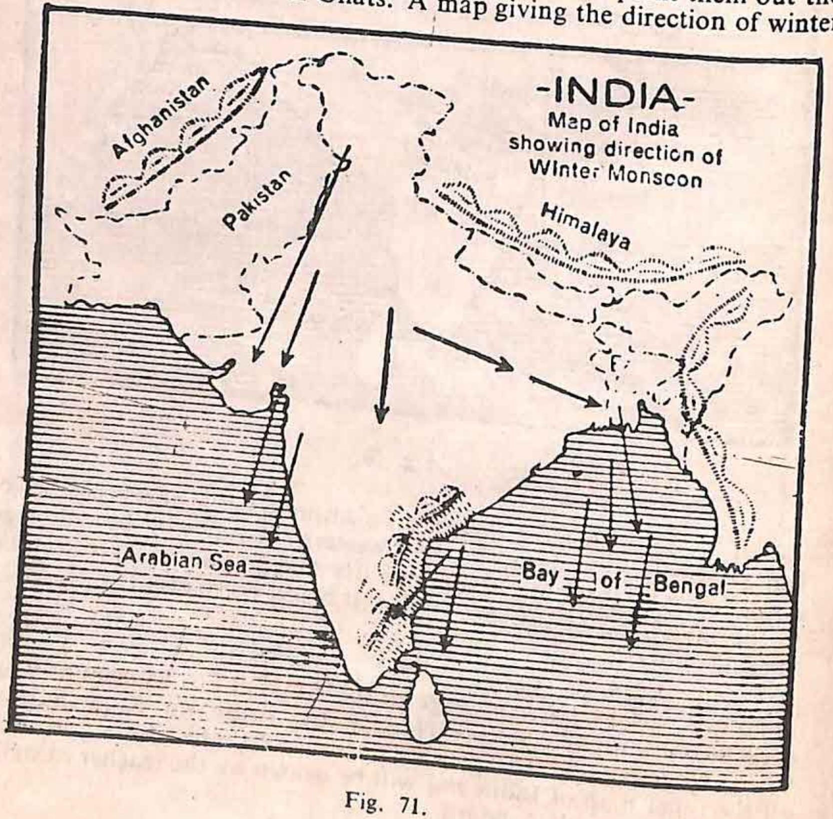

Fig. 71.

monsoons and areas having winter rainfall will be prepared on the black-board in the presence of the pupils as shown in Fig. 71.

Unit IV: Winter rainfall in Punjab due to cyclones. The attack of cyclones on the Hindukush, the Sulaiman mountains and the Punjab hills will be explained in outlines with the help of a map shown below (Fig. 72).

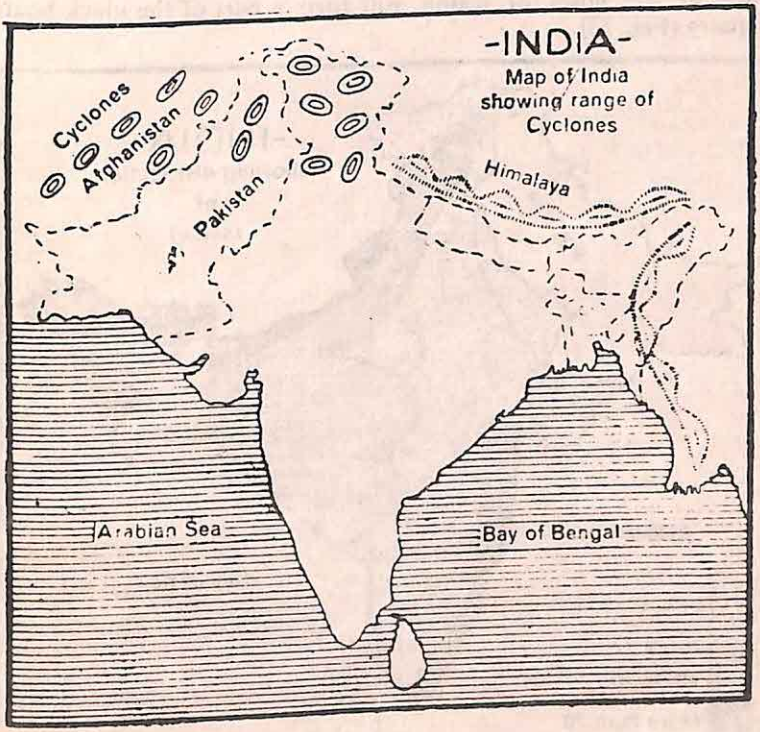

Fig. 72.

Final Recapitulation: In order to summarise the whole lesson the following questions will be asked :

1. Why does rainfall decrease as we go up the Ganges Valley and increase as we go up the Indus Valley ?
2. Name the parts of India which receive rainfall in winter due to winter monsoons.
3. Account for the winter rainfall in the Punjab.
4. Why does Tamil Nadu get rainfall from both the monsoons ?

Application : The following questions will be set for home-task.

1. Draw two maps of India showing summer and winter rainfall.

2. Draw a map of India showing dry and wet areas.

Black-Board Summary: The black-board summary will be developed with the development of the lesson. Mostly, it will consist of answers to the recapitulatory questions. The diagrams shown in the notes of lesson will form a part of the black-board summary (Fig. 73).

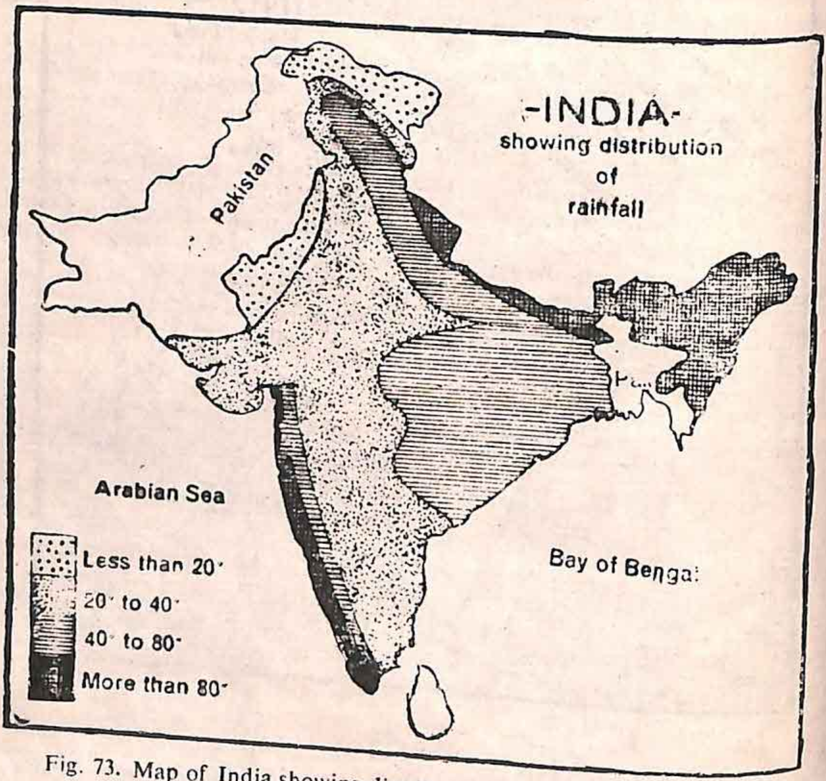

Fig. 73. Map of India showing distribution of rainfall by shading or colour or layer tint method

1. *Kinds of Monsoons*:

(a) Summer Monsoons

(b) Winter Monsoons.

(A) Summer Monsoons are also called South West Monsoons because they come from S.W. base. They have the following branches:

(i) Bay of Bengal Branch.

(ii) Arabian Sea Branch.

(iii) Western Ghat Branch.

(iv) Narbada Valley Branch.

(v) Rajasthan and Sind (Pakistan) Branch.

(B) Winter Monsoons are also called North-East Monsoons because they come from N.E. base. Regions of winter rainfall are Punjab, Tamil Nadu and the East Coast of Ceylon.

32

Lesson on the Causes of Currents

Class	IX
Average Age	14 years
Subject	Geography
Topic	Causes of Currents
Time	45 minutes

Apparatus : Usual class room apparatus and a map of the world showing currents. An apparatus and its diagram to show that water keeps its level. Another diagram showing the direction of winds. A chart showing clockwise and anti-clockwise movement of currents in the ocean. A chart showing currents of the Atlantic ocean.

Aim : (1) To make pupils understand the causes of currents, and (2) to broaden their outlook by providing new information.

Previous knowledge : Pupils are already acquainted with the major and the minor oceanic movements. They have previously studied the Ferrel's Law.

Introduction : The teacher will ask the following questions to test the previous knowledge of the boys :

1. What different types of movements are found in an ocean?
2. What is the difference between a wave and a current ?

Announcement of the aim : The teacher will announce : "Let us to-day study the causes of the currents."

UNIT I. CAUSES OF THE CURRENTS

Presentation

(a) *Difference in Temperature* : The teacher will adduce from pupils the distribution of insolation with the help of a sketch map drawn on the black-board as shown in Fig. 74 and will tell them that the hot water of equator expands after it gets heated and moves along the surface of the ocean towards the poles, while the cold denser water of higher latitude creeps down and is warmed on reaching warm latitudes.

There it rises and flows towards the poles. A diagram to illustrate this will be drawn on the black-board. In order to make it clear examples of Gulf Stream Drift which expands and moves towards cold latitude and the cold Labrador current of the Atlantic ocean

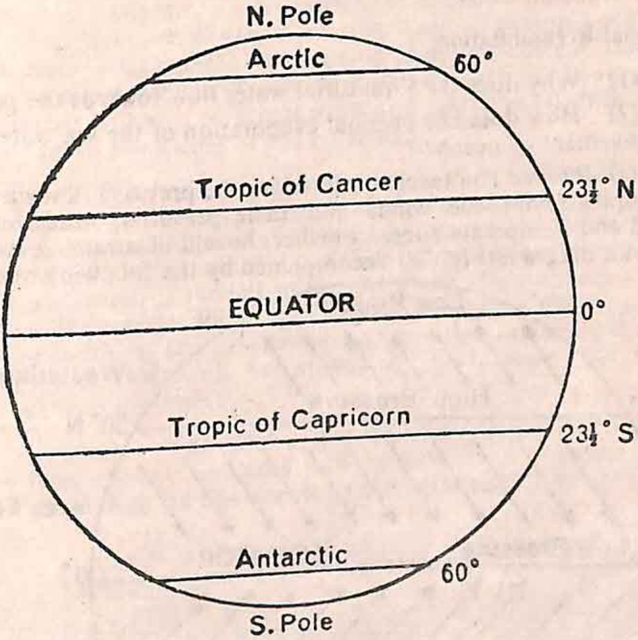

Fig. 74. World Heat Zones

which moves down to the equatorial lands will be quoted.

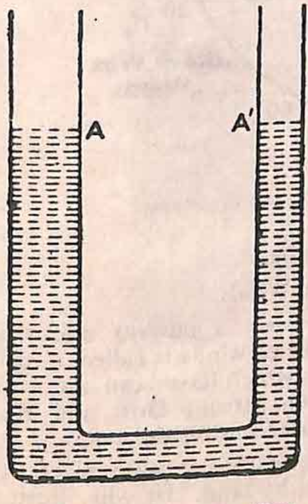

Fig. 75. Apparatus to show that water keeps it level

(b) *Unequal Evaporation* : The teacher will ask his pupils to name places where the possibilities of evaporation are greater and will then draw their attention to the experiment to prove that water keeps its level. This experiment will be performed by the teacher in the class.

Experiment : The teacher will pour water in tubes of different dimensions. It will stand at the same height in both the tubes as shown in Fig. 75.

Students will apply this conclusion explaining the flow of currents from the Baltic to the Atlantic and from the Atlantic to the Mediterranean sea. It will be pointed out that the Mediterranean sea is surrounded by the deserts and therefore, gets its water evaporated. On the other hand, the Baltic sea receives large supplies of fresh water from European river.

Sectional Recapitulation

(1) Why does the Equatorial water flow towards the poles ?

(2) How does the unequal evaporation of the sea water affect the movement of oceans ?

(c) *Winds* : The teacher will revise the previous knowledge of his pupils about the winds and their prevailing direction in the Torrid and Temperate zones. Further, he will illustrate it with the help of a diagram (Fig. 76) accompanied by the following questions:-

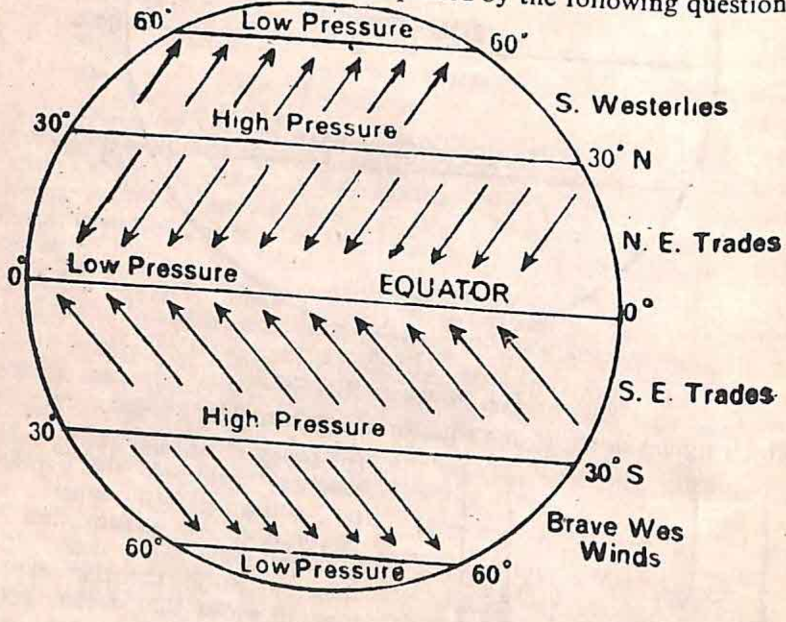

Fig. 76. Permanent Winds and their directions

What is the direction of the Westerlies ?

What is the direction of the Trade Winds ?

After this, he will differentiate between a current and drift, that a current flowing under the influence of winds is called a drift. He will present examples of the currents which have been influenced by the Trades and Westerlies like the Gulf Stream Drift and Kuro Siwo Drift. Their directions will be pointed out on the map.

(d) *Relief* : The teacher will tell them that at many places the original course of a current is obstructed by land. He will illustrate it from the wall map how the land at the Equator prevents complete circulation of water round the earth from east to west and deflects currents northwards and southwards. Further, he will show, how in the South Atlantic, water is deflected north by the land mass of Africa and is named Benguela current. Another example of this is the South Equatorial current which becomes Brazil current due to the existence of Cape Saint Roque on the east coast of South America. The teacher will give sufficient mass and individual drill in the pronunciation of the names of the currents.

(e) *Rotation of the earth* : The application of Ferrel's law will be introduced to explain the effect of the rotation of the earth. The teacher will tell them that all moving bodies on the surface of the earth are deflected to the right of their course in the Northern Hemisphere and towards the left in the Southern Hemisphere. He will illustrate it from the map, how currents instead of flowing towards north or south, as the case may be, turn either left or right of their true courses. This will be proved by performing the following experiment in the class :

Experiment : The Globe will be rotated and a line will be drawn from above. Students will observe that the line has been turned away from its due course to the rotation of the earth.

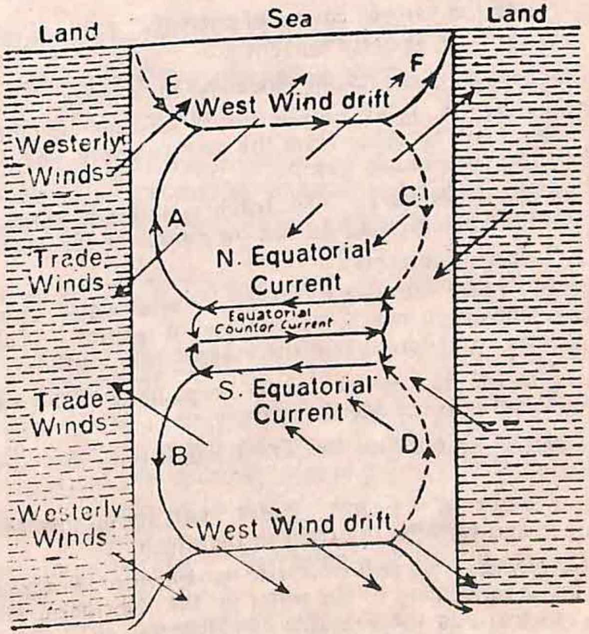

Fig. 77. Clockwise and Anti-clockwise circulation of the Ocean Currents

Sectional Recapitulation

(1) How do winds cause currents ?

(2) What part does the relief of land play in the movement of water ?

UNIT II

The clockwise and anti-clockwise circulation of ocean currents : It will be explained by a diagram that the movements are clockwise in the Northern Hemisphere but anti-clockwise in the Southern Hemisphere due to the combined effect of all the factors stated above (Fig. 77).

The teacher will link in this knowledge with the previous knowledge of his pupils telling them that this law governing currents conforms to the general direction of the winds. After this the meaning of the warm and the cold currents will be explained and concrete examples will be put forward by the teacher. It will be stressed that unlike wind, currents are named according to the direction towards which they flow.

Recapitulation : The teacher will put the following question to revise the whole lesson :

1. Name the various causes of currents.
2. What is an easterly current ?
3. Where do you find the clockwise movement ?

Application : A brief outline study of the currents of the Atlantic Ocean will be made from the map to apply the knowledge gained by them in to-day's lesson.

Black-board summary : The teacher will write the following summary on the black-board during the course of the lesson :

(1) Causes of currents :

(a) *Difference in Temperature* : Warm water expands and moves as a surface current towards the cold regions. It sinks there and returns as an under-current towards warmer latitudes.

(b) *Unequal evaporation* : Water keeps its level. So water flows from the Atlantic to the Mediterranean sea.

(c) *Winds* : Westerlies and Trade winds push the water ahead of them.

(d) *Rotation of the earth* : Water swirls round towards the left in the south and towards the right in the north.

(2) *Clockwise and anti-clockwise movement of the water* : There is a clockwise movement of the water in the Northern Hemisphere and anti-clockwise in the southern hemisphere.

(3) *Name of a current* : An east current is one which goes to the east and west current is one which goes to the west.

33

Lesson on the Equatorial Region

Subject	Geography
Class	IX.
Topic	The Equatorial Region
Time	40 minutes
Average Age	14 years

Illustrative Aids

(i) Ordinary class-room apparatus.

(ii) A wall map of the world showing the Equatorial Region.

(iii) An outline globe showing the situation of the region.

Aim : (i) To study the situation of the Equatorial Region, its climate, rainfall, temperature, natural vegetation, agricultural products, animals, population, countries included and the important cities.

(ii) To broaden their vision and outlook by giving new information.

(iii) To acquaint the student with the effect of climate on vegetation and occupations.

Previous Knowledge : Pupils have already read the natural regions of India, Asia and other continents in their previous classes. So the teacher will put the following question ?

What is a natural region ?

Announcement of the aim : "Well boys, to-day we shall study the Equatorial Region."

Presentation : The teacher will hang the map before the class and will ask a student to point out equator on the map.

The lesson will be divided into the following units :

Matter	*Method*
1. Situation :	
Between 5°N and 5°S of equator.	1. The teacher will show the situation of the region on the world map and will also explain it with the help of an outline globe ? What is the position of the Equatorial Region.
2. Countries included :	
(i) The Amazon Basin i.e. Northern Brazil. (ii) The Congo Basin. (iii) Indonesia, Kalimantan. Andalas, Jawa, and Malaysia.	2. The teacher will ask the students to look at the map and name the countries included in this region. He will also show these countries on the map. Name the countries included in the Equatorial Region.
3. Climate :	
Average temperature about 80°C throughout the year. It rains every afternoon 80″ average annual rainfall.	3. The teacher will adduce information from the students in the following manner : If the temperature of the place remains above 80° what sort of climate ? If the temperature is above 80° but it rains daily, what would be the climate ? (Hot and moist). Therefore the climate in the Equatorial Region hot and moist. Describe the climate of the Equatorial Region.
4. Products :	
(i) Natural Vegetation : Dense forests. (ii) Agricultural Products : Sugar-cane, rice, tea, coffee, spices.	4. If the temperature is high and it rains heavily what would be the natural vegetation ? The teacher will adduce from the students the agricultural products of the places where the forests have been created. What is the natural vegetation in the Equatorial Region ?

Matter	*Method*
	What are the agricultural products there ?
5. Animals :	
(i) What animals jump from tree to tree? (ii) Who can crawl ? (iii) Who can force their way through thick forests ?	6. The teacher will adduce from the students what sort of animals can live in the thick forests ? What sort of animals are found in this region ?
6. Population and Occupation :	
Very thinly populated. Hunting, collection of ivory. Agriculture where forests have been cleared.	6. The teacher will adduce from the students that forests are thinly populated. What would be the occupation of the people living in the forests ? What are the occupations of the people where the forests have been cleared ? Why is the region so thinly populated ?
7. Important Cities :	
(i) Para—in Barzil. (ii) Boma—in Central Africa (iii) Singapore.	7. The teacher will show these cities on the map. Show the important cities of this region on the World Map.

Recapitulation

(i) On the map, show the situation of the Equatorial Region

(ii) Name of the countries included in this region ?

(iii) What is the climate of this region ?

(iv) What are the products of this region ?

(v) Name the animals found in this region ?

(vi) How does the climate affect the population and occupations of the people in this region ?

(vii) Name the most important cities in this region ?

Application ·

Draw a map of the world and Show the Equatorial Region.

Black-board Summary

Situation : Between 5°N and 5°S of equator.
Climate : Hot and moist. *Products* : Forests.
Agricultural Products : Sugar-cane, rice, coffee, spices, tea.
Animals : Monkeys, snakes, frogs, elephants and crocodiles.
Population : Very thinly populated.
Occupations : Hunting, collection of ivory, agriculture.
Areas : Amazon Basin, Congo Basin, Indonesia.
Important Cities : Para, Boma, Singapore.

34

Lesson on Rice Cultivation in Monsoon Asia

Subject	Geography.
Title of the lesson	Rice Cultivation in Monsoon Asia.
Class	Std. V.
No. of Pupils	26.
Average age	12 yrs.
Time allotted	35 minutes.

Aim.

General : To help the children develop a wide outlook and broad vision of human life and also to help them understand the factors that influence the life, activities and progress of the people of any region.

Particular : To help the pupils learn the features of rice cultivation and realize its importance in the economy of the monsoon lands.

Previous knowledge : The pupils know the physical features of Asia and the features of the monsoon climate.

Apparatus : Maps of Asia—physical features, rainfall and rice lands, pictures, the model of 'donga', atlases.

Steps	*Matter*	*Method* *Teacher's Work* :	*Method* *Pupils' Work* :
Introduction	Class talk on staple food of Indians and Europeans.	1. What do the Indians eat as their main food ?	Pupils will answer : it is rice.
		2. Do the Europeans eat rice also?	They do not eat rice ; they eat bread made

Steps	Matter	Method	
		Teacher's Work :	Pupils' Work
		3. What do they eat ?	from wheat flour.
		4. Why is there this difference in diet	The pupils' answer that rice does not grow in Europe.
Presentation		To elicit from the pupils the conditions necessary for rice cultivation.	
	Conditions necessary for the cultivation of rice : hot, wet climate, flat land, fertile soil.	Teacher will ask 1. Does rice grow in India ?	The pupils' answer that rice grows in India.
		2. What are the climatic conditions of India ?	India has a hot and wet climate.
		Teacher will then show a picture of a rice field and ask :	
		1. What do you think is the nature of the land ?	The pupils answer that the land is flat.
		2. Do you notice anything particular about the rice fields besides their flatness ?	Pupile see that the rice fields are flooded.
		Teacher explains why the fields are flooded and also tells the pupils why it is necessary for the soil to be fertile.	

Steps :	*Matter :*	*Method :*	
		Teacher's Work :	*Pupils' Work :*
		Teacher will now refer to the maps of Asia and draw out answers from the pupils as to the location of rice.	Studying the maps pupils will find out areas where rice is grown, and point then out.
	Rice-lands of Asia :- on flat river valleys and deltas where there is sufficient water.	1. Which areas of the monsoon lands will have the necessary conditions for rice cultivation.	River valleys of India, China, Japan, Burma, Thailand, Laos, Cambodia North and South Vietnam (Fig. 78).

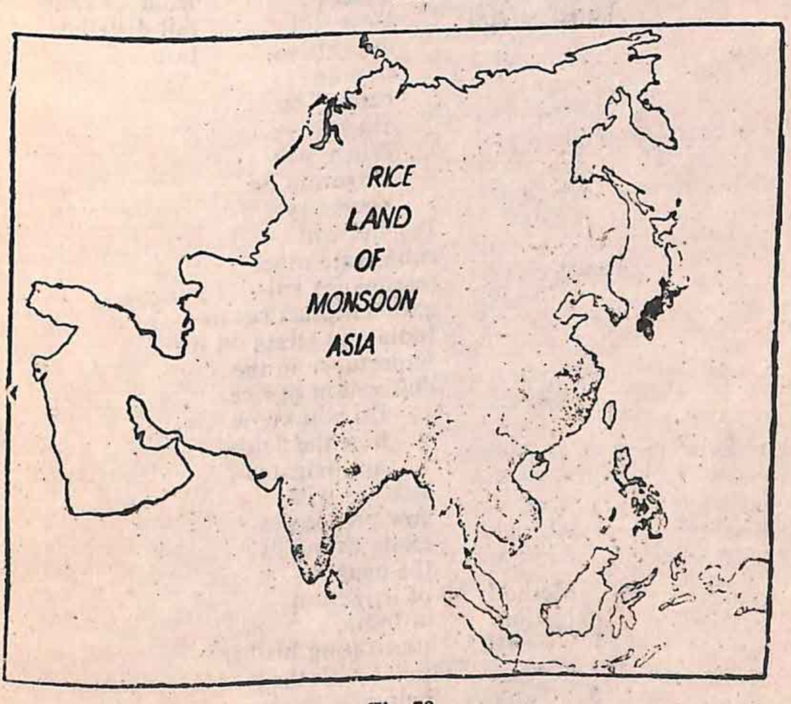

Fig. 78

Steps :	*Matter* :	*Method* :	
		Teacher's Work :	*Pupils' Work* :
Development :	Rice-cultivation in India : Location of rice lands : necessity of irrigation, due to uncertain and ill distributed rainfall.	Referring to a map of India teacher asks : 1. Will there be sufficient rainfall at all places ? 2. How will the cultivation be carried on them ? 3. Where will irrigation be necessary ? Teacher will enumerate other reasons for irrigational practices in India and stress on its importance in the cultivation of rice. 1. Do you know how the fields are irrigated ?	Pupils will answer after studying the map of India and recapitulating previous knowledge of rainfall distribution.
	Methods of irrigation. 1. Canals. 5. Wells. 3. Tanks.	Teacher will now proceed to relate to pupils the methods of irrigation in India, illustrating his/her point with the help of a model and blackboard sketches.	
	For rice cultivation in China, the south humid lands ideally suited for rice cultivation.	With reference to the map, teacher asks pupils to locate rice areas in China.	The pupils name the rice regions of China.
		Referring to the picture of	

Steps :	*Matter :*	*Method :*	
		Teacher's Work :	*Pupils' Work :*
		rice fields in China, the teacher will emphasise the hard labour entailed in rice cultivation. Teacher will direct the pupils', observation towards paucity of low-lying areas in Japan.	
		1. Do you find many low-land areas in Japan ? 2. How could rice be grown then ?	Pupils study physical features of Japan, and answer.
		Teacher refers to a picture of terrace cultivation in Japan and asks : 1. What do you notice in the picture ? 2. What do they look like ?	Pupils will answer—fields along the slopes, give the general appearance of steps.
		Teacher explains how terraces are cut and flat land made available along the slopes.	
Conclusion :	The story of rice : 1. Ploughing the field. 2. The nursery bed. 3. Transplanting. 4. Irrigation.	Teacher shows a series of pictures and by asking questions help the pupils to learn the different stages in the cultivation and processing	The pupils see the pictures and answer questions.

Steps :	*Matter :*	*Method :*	
		Teacher's Work :	*Pupils' Work :*
	5. The rice corn. 6. Harvesting. 7. Threshing. 8. Winnowing. 9. Pounding. 10. Marketing.	of paddy and rice.	
Recapitulation :	Teacher asks the pupils to study the picture of a paddy field and answer the following questions. (a) How can you tell that the climate is hot and wet ? (b) What other conditions are necessary for rice cultivation ? (c) Why is rice planting an arduous job ? (d) Why cannot machines do the work ?		
Application :	1. Draw an outline map of Asia and show distribution of rice by dot method. 2. Write a geographical account of rice cultivation.		

APPENDIX-I

Suggested Questions on the Teaching of Geography

PART I

TEACHING OF GEOGRAPHY

1. What are the objectives and values of teaching Geography in Schools ? How would you proceed to prepare the teaching Syllabus and to teach the Syllabus in order to fulfil these aims in Geography ?

2. What types of climate are found on the west coast of a land mass stretching from equatorial area to the arctic circle ? Give a detailed description of those that occur in the Temperate Zone from amongst those you mention

3. Describe the method you would use to prepare a class of young children to understand what a map means. Give the various steps up to their introduction to a wall or an atlas map.

4. In physical, more than in regional Geography, it is difficult to guard against unreality and to forget the main aim for teaching geography. Why is this so and what precautions do you suggest could be taken to prevent this occurring ?

5. How would you make use of the home district in teaching regional geography in the Secondary Schools ?

6. Do you think it is necessary to teach Geography as a Compulsory Subject in the Secondary Schools of your country? Give reasons in support of your views. In this connection, discuss fully its correlation with other subjects.

7. Assess the value of globes, maps and charts in teaching Physical Geography.

8. "Pictures in Geography are not merely illustrative ; they are fundamental." Discuss the statement in connection with the teaching of regional geography.

9. "The Geography Room is a workshop, and its general atmosphere should be such as to stimulate the imagination and give inspiration to the pupil in a manner which is impossible when many subjects are taken in the same room." Indicate how you propose to equip your Geography room to serve your purpose in the light of the above statement.

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		Teacher's Work :	Pupils' Work :
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10. What instruments, maps and chart would you keep in your school for teaching Climatology in the Higher classes of your school ? Explain their utility and discuss the bearing of Climatology in the study of Geography.

11. Indicate the importance of proper equipment for the effective teaching of Geography in Schools. In this connection, state and draw sketches, wherever possible, of the equipment that you propose to use for a lesson on the natural vegetation of Africa for the students of class VII.

12. Select a mountainous terrain of India for a geographical excursion for the pupils of higher classes of your school. Suggest the steps that you would like to make it most profitable.

13. Geography is essentially an open air subject. Explain clearly what you mean by the above statement and state the open air activities that you propose to introduce in your school for teaching the subject.

14. Bring out the significance of field excursion in introducing Regional Geography.

15. Suggest experiments to demonstrate the usefulness of maps in geographical studies.

16. Give an account of the equipments needed for furnishing geography rooms.

17. Geography has risen to a position of utmost importance in the curriculum, and no secondary school course can be regarded as complete unless adequate provision is made for the teaching of the subject up to and including preparation for the Higher Secondary examination. Discuss the statement, explaining how the development has taken place in the subject during the last century and why it is being considered as an important subject.

18. Trace briefly the development of geography teaching in general.

19. What do you understand by physical Geography and how did it come to be introduced in schools ?

20. Discuss the following definitions of geography :

(a) Geography is the description of the earth.

(b) Geography deals with the adjustment of human groups to their physical environments.

(c) Geography is the study of the interaction between man and his environments.

21. Explain : "The function of geography is to train future citizens to imagine accurately the conditions of the great world stage and to help them to think sanely about political and social problems in the world around."

22. What is the modern conception of geography ?

23. Explain: "Geography is a link between the scientific and the human subjects."

24. How does Geography help in broadcasting the outlook of pupils ?

25. What do you understand by human geography ?

26. Physical conditions have great influence on human beings. And also human beings have some freedom and are not entirely dependent on their environments. Discuss the above and give examples in its corroboration.

27. How does geography help in the development of world citizenship ?

28. What educational objectives can be achieved through the teaching of geography in the schools ? How far does the presentation of the material of the present day teacher differ from the geography teacher of the past ?

29. How does new geography differ from old geography ?

30 What do you understond by human geography ? Explain how far the following statement is correct ? "Human beings have some freedom and are not entirely dependent on their environments."

31. Give reasons for including geography in the school syllabus.

32. (a) How does geography compare with other subjects in achieving the aim of education ?

(b) Do you think there is more reason for teaching pupils how to study geography than how to study other subjects ?

33. What is the importance of geography in the present day times ?

34. "Geography, properly taught can help pupils not only in understanding but also in getting into real sympathy with the people of other lands." Show how you will try to keep the aim in view when teaching the geography of India or Ceylon or China or Japan to a mixed class of all communities.

35 In various discussion lessons pupils offered the following answers. How will you deal with them ?

(i) Arctic region is cool.

(ii) Canals have been constructed in Germany for irrigation.

(iii) Bengal produces wheat and England produces cotton.

(iv) The people living in the interior of central Africa are highly industrialised.

(v) Quetta is situated in Baluchistan.

(vi) Tibet is on the top of India.

(vii) Mysore is in the tropics, while Delhi is in the temperate zone. Therefore the hot weather in Mysore must be worse than the hot weather in Delhi.

(viii) Sind is nearer the sea so the climate there must be moist.

(ix) We actually see that the land all round is flat. How can we believe that the earth is round.

36. What are the practical and cultural aims of the teaching of geography and what relation should exist between the two ?

37. What aims would you keep in view while teaching geography in primary and middle classes ? How would you achieve these aims in the primary classes ?

38. Explain why geography should be included in the school curriculum. What aims and objects are fulfilled by doing so ?

39. How would you correlate the teaching of history and geography in the middle classes ?

40. In what ways and to what extent can geography be correlated with other school subjects ? Illustrate.

41. How does geography compare with other subjects in regard to lending itself to correlation ? Is it practicable to attempt correlation where each subject is taught by a different teacher ?

42. Explain how the teaching of geography helps to under stand current affairs.

43. How would you correlate geography (i) with Mathematics and (ii) with daily life.

44. Estimate the importance of local material in the teaching of geography at various stage. Illustrate your answer.

45. Draw up an outline scheme of teaching physical geography in classes III and IV.

46. At what stage should the teaching of geography begin and how ? Draw up briefly the syllabus for the primary classes and criticise the existing primary syllabus of your province.

47. What is the importance of home geography in teaching general geography ? What topics you would include in the study of home geography ?

48. Why is it necessary to emphasize facts in the teaching of geography ? How would you select and emphasize these facts ?

49. What suggestions would you give to a young teacher regarding the spelling and pronunciation of geographical names ?

50. What use would you make of a slate globe in a primary school in teaching geography ?

51. What are the principles that must be kept in mind while planning a geography syllabus ?

52. What principles would you bear in mind in drawing up the syllabus in geography for elementary schools ? How far have these principles been kept in view so far as the existing syllabus in your state is concerned ?

53. What principles will you bear in mind while preparing syllabus for middle and high schools ? Criticise the existing syllabus of your Education Board for the middle schools ?

54. Discuss the importance of map work in the middle and high schools. Show how and to what extent you will teach the map work.

55. Draw up an ideal syllabus for middle classes, giving reasons for the inclusion of any topic.

56. What test would you apply to determine whether this or that particular topic should or should not be included in the geography syllabus ? How far would you include structure, soil and climate in teaching geography ?

57. How would you give your pupils an idea of contours ?

58. (a) What exercise do you suggest in Practical Geography for the middle classes of the school ?

(b) What use would you make of weather observation record in teaching geography ?

(c) What are the various ways of approach for the study of the Peoples and continents (world geography) in junior classes ? Which do you prefer and why ?

(d) In what order would you teach continents in the middle classes ?

59. In what respects do the aims of teaching geography at the secondary stage differ from those of the elementary stage ?

60. Bring out the value of school journeys to supplement school teaching. Suggest a particular journey and mention the points you would emphasize.

61. Explain with examples how the regional method of teaching geography can help the teacher in reducing the burden on the pupils of learning a large mass of useless facts.

62. Narrate briefly the various methods adopted for the teaching of geography in primary and middle classes. Discuss one of these methods giving reasons for your choice.

63. What do you understand by the regional method of teaching geography ? In what way is it superior to the old method ?

64. Discuss the various methods of teaching geography in schools. Which of these do you like the most and why ?

65. Suggest a scheme of open air work or handwork for students of primary classes.

66. Write notes of a lesson on one of the following topics, conforming to the principles of good teaching :

(a) The distribution of population in India.

(b) The air routes of India.

67. Draw up an outline scheme for a series of lessons suited to high classes on the economic geography of India.

68. Outline a series of lessons on one of the following :

(a) Irrigation and Agriculture in the Punjab.

(b) The hinterlands of Bombay, Karachi and Rangoon—classes IX and X.

69. Draw up notes of lessons for teaching one of the following topics :

(a) Physical features of Italy.

(b) Study of the cardinal directions in a primary class.

70. Draw up an outline scheme of a lesson for class VI or VII to show the influence of climatic conditions on the occupation of the people (you may select any geographical region in India for this purpose).

71. Write notes of a lesson for teaching one of the following :

(a) Relief of Asia, IX class.

(b) Study of seasons in a primary class.

(c) A railway journey from Delhi to Calcutta.

(d) A visit to the head-works of one of the major canals of the Punjab.

(e) Canal systems of the Punjab.

(f) Distribution and occupations of the people in different States of India.

(g) The equatorial region.

72. What should be the special features of a geography room ? Which of these would you leave out if you had only a moderate sum of money at your disposal ?

73. What place in Geography teaching would you give to (a) text books, (b) practical work at different stages?

74. Critically consider the value of different visual aids in the teaching of geography in the middle and high classes.

75. How will you fit up the geography room in your school ? What use will you make of the various kinds of material that forms part of your geographical collections ?

76. A donor wishes to help you in equipping your geography room (only 30′ × 22′) with books, maps, apparatus, furniture, magazines etc, upto a limit of Rs. 1500. Draw up a list of your requirements. Ordinary furniture of the room is already provided.

77. Discuss text books and their place in geography with special reference to those used in your State in the primary and middle classes.

78. What are the chief dangers which a geography teacher must avoid in the use of (a) maps, (b) models.

79. (a) One of the real disadvantages of a text book in geography is that it soon gets out of date. What efforts will you make to keep yourself up-to-date ?

(b) Make a list of twenty books which you think a geography reference library should contain.

80. "Pictures and maps in geography are not mere illustrations but they are fundamentals also." Discuss the statement.

81. Discuss in detail the value of maps in teaching of geography.

82. Show the necessity of a geography museum ?

83. How would you set about making a geography museum ?

84. What is the educational value of a geography museum in a school ?

85. Suppose you are put in charge of a museum, how would you run it successfully ?

86. "A geography museum is a great asset to a school." Discuss.

87. Discuss the importance of handwork in geography.

88. How will you correlate geography with hand work ?

APPENDIX-II

Suggested Questions on Physiography

PART II

PHYSIOGRAPHY

1. Describe the work of river as agent of erosion, transportation and deposition. What typical features of the landscape are due to each of these activities of the river? Illustrate your answer with reference to the different land forms as found in the Ganges valley.

2. The following data are given :

Date of the year = 1st January, 1970.
The sun's altitude at noon = 12 degrees.
Declination of the sun = 23 south.

Determine the position and latitude of the place.

3. Account for the differences regarding the distribution of rainfall in different parts of India.

4. Draw necessary diagrams and explain any two of the following :

(i) Land breeze and Sea breeze.
(ii) Cyclone and anticyclone.
(iii) Trade winds and westerlies.

5. Describe with neat sketches the currents of either the Atlantic or the Indian ocean.

6. Explain as far as you can, the action of running water and glacier as agents of denudation. Describe the typical features of flavial and glacial land forms.

7. What is meant by the crust of the earth? Name the common rocks forming the crust of the earth and classify them according to their mode of formation.

8. Explain clearly what do you understand by Natural region? Give an account of the conditions relating to climate, natural vegetation and agriculture in one of the natural regions of the Indo-Ganetic plain or the equatorial region.

9. Show the difference between tides and ocean currents. How are they caused ? Explain the geographical significance of the study of these types of movements of oceanic water,

10. What are sedimentary rocks ? How are they formed ? Classify them on the basis of their formation, giving examples of each type.

11. Explain the formation of the river valley at the various stages of its development. Discuss the geographical significance of the river in the life of man.

12. Explain the causes of rainfall. Discuss the different types of rainfall and give an account of their world distribution.

13. Discuss with references to Durgapur, Rourkela and Bhadravati the factors for localisation of Iron and Steel Industry.

14. Define maximum temperature and minimum temperature. How is the mean daily temperature found ?

15. The following table gives the maximum and minimum temperatures. Find out their mean and draw a curve showing the result.

Date	Maximum	Minimum
1	52 F	48 F.
2	51 F	48 F.
3	51 F	48 F.
4	51 F	47 F.
5	50 F	40 F.
6	49 F	39 F.

16. (a) Define an isotherm.

(b) What are the differences between a typical oceanic climate and a typical continental climate ?

17. Draw the diagram of the various types of thermometers that are used in schools. Describe the working of the Maximum and Minimum thermometer.

18. Name the factors on which the climate of a place depends.

19. Differentiate between climate and weather and discuss the value of each for human activity.

20. Describe the construction of a barometer and draw its diagram.

21. How can a barometer be used to measure the height of a place ? Explain the principle upon which this use of barometer depends.

22. Define isobar, cyclone, and anticyclone.

23. Show by means of a diagram the distribution of high and low pressure in the world.

24. Describe the various types of winds that you know.

25. Give some account of the causes of rainfall.

26. How is rainfall measured ? Where does rain fall most in India ?

27. Name the various types of rainfall. Add a short account of each.

28. Prepare a statistical diagram for the following figures, showing rainfall in inches :

January	2.05	July	0.69
February	2.48	August	3.23
March	2.82	September	3.20
April	0.81	October	1.27
May	2.19	November	0.87
June	0.67	December	1.78

29. What heavenly bodies revolve round the sun as their centre ? How would you distinguish Venus from the other planets ?

30. What is the shape of the earth ?
Why does it appear to be flat ?

31. How can you prove that the earth is round like ball ?
Why mountains and valleys do not effect its roundness ?

32. Distinguish the celestial poles from the terrestrial poles.
How would you find the Pole Star on a clear night ?

33. What are the motions of the earth ?
What effects do they produce ?

34. How will you prove that the earth rotates on its axis ?
(Hint : from the apparent daily motion of the sun).

35. What proof have you that the earth revolves ?

36. Explain clearly how days and nights are caused. Why do they increase and decrease in length ?

37. Where and when are the days and nights equal throughout the year ? Why are they not so everywhere ? Give a full explanation.

38. What is the change of seasons due to ? What part does the inclination of the earth's axis play in their regular succession ?

39. Give the reasons for the following :—

(a) Mornings and evenings are less-warm than noon.

(b) Noon is less warm than afternoon.

(c) Summer is hotter than winter.

(d) July is hotter than June.

40. Explain the term Midnight Sun. Name the places where the midnight sun can be seen.

41. What is the twilight and how does it take place ?

42. Explain the following terms :

Altitude of the sun ; tropics ; solstice ; equinox ; perihelion ; nadir ; antarctic ; antipodes.

43. What is a longitude ? Distinguish it from a line of longitude. Why does it decrease in length as it gets farther from the equator ?

44. What is a latitude? How would you determine the latitude of a place from the pole star ?

45. What purpose do latitude and longitude serve ? How would you determine the latitude of your town on 21st March ?

46. The latitude of Calcutta is 22½ degrees N ; its longitude is 88½ degrees E. Find the latitude and longitude of its antipodes.

47. Explain the terms "local time" and "standard time". Why is the former not much used in everyday life.

48. Find the time at Delhi and at Bombay when it is 5 A.M. at Paris.

49. When it is 11.30 P.M. at Calcutta, what time it be will at New York and at London ?

50. How is the longitude of a place determined when the local and Greenwich times are known ?

51. Find the longitude of a place when the local noon occurs at 2.40 P.M. by Greenwich time.

52. What is the longitude of a place when the local time and the Greenwich time are 2.55 A.M. and 4.40 P.M. respectively ?

53. Explain the following terms :—

Date Line, Great Circle, Prime Meridian and Compass.

54. When should a signaller wire from London to Melbourne (145 E.) and to Quebec (70 W), so that the messages may be received in both places at 6 A.M., the period of transit to each place being only 30 seconds.

55. Calculate to the nearest degree the longitude of Melbourne and Buenos Aires, which are respectively 9 hours 39 minutes and 35 seconds fast and 3 hours 53 minutes and 29 seconds slow by Greenwitch.

56. What will be the difference in the times of two places which are 35½ degrees east or west of each other ?

57. Explain fully why a day appears to be lost in sailing round the earth from east to west and gained when sailing from west to east

58. In what different ways may the earth be represented ? Give the details of structure of a terrestrial globe.

59. What is a map ? How does it differ from a globe ? Why is the former used more largely than the latter ?

60. Why is it impossible to draw a map accurately representing the earth's surface ? What general principle is employed to avoid as far as possible, the chief inaccuracies ?

61. Explain the term "Map projection." What projections are used for the maps of the world ?

62. Describe the Globular projection. What advantages does it have over the Stereographic and Orthographic projection ?

63. What are the advantages and disadvantages of Mercator's projection ? How far is it based on the Cylindrical projection ?

64. What are Contours ? What purpose do they serve on a map ? How do they differ from Hachures ?

65. Name the projection which you find most suitable for the following :—

(a) A map of the polar regions.

(b) A map of the Tamil Nadu.

(c) A map showing the Tourist Centres of India.

(d) A map showing the routes for steamers and air-ships.

(e) A map showing the comparative productions of cotton, coal, and rubber, and also the comparative density of population in the world

66. What is meant by the scale or a map, and what use may be made of it ?

67. What is meant by the phases of the moon ? Explain with the help of a diagram how they take place.

68. "The time of rising and setting of the moon gets later each day by about an hour." Account for this fact.

69 How is the lunar eclipse caused ? Why does it not occur once every month ?

70. What do you understand by the solar eclipse, the partial solar eclipse, and the annular solar eclipse ? Illustrate your answer by a diagram.

71. In what respect do comets differ from planets and stars and why do they appear at such long intervals ?

72. Write short notes on the following :—

Solar System, Meteors, Milky Way and Satellites.

73. What do you understand by the crust of the earth ? Show how it was originally formed.

74. What are rocks ? Into what classes are they divided? Give a short description of each.

75. How would you prove that the temperature of the interior of the earth is high ?

76. What is a volcano ? How is it formed ? Into what classes are volcanoes divided ?

77. What is meant by an earthquake ? Explain clearly how it is caused.

78. Distinguish continental island from oceanic islands. Describe how each is formed.

79. What are geysers ? What does their existence show ? Where are they generally found ?

80. Write short notes on :

Faults, crust-blocks, dissected plateau, atoll, sinter, fossils.

81. The land surface of the earth is constantly undergoing change. What are the chief external agents of the change ? Describe the kind of work done by any two of those you mention.

82. How do rain and rivers bring about changes on the surface of the earth ?

83. Explain clearly how springs are formed. How many kinds of springs are there ?

84. What are artesian wells ? How are they formed? Illustrate your answer by a diagram.

85. What is a delta and how is it formed ?

86. What is a glacier ? How is it formed ? Explain its action upon the rocks over which it passes.

87. Explain the action of frost and heat and the sea in bringing about changes on the surface of the earth.

88. Write notes on :

Snow-line, area of inland drainage, estuary, glaciated valleys, icebergs, meanders and denudation.

89. Why is sea-water salty ? Why does this saltness differ in different parts of the sea ?

90. What are waves ? Distinguish them from currents.

91. How are ocean currents caused ? Into what classes are they divided ?

92. Compare the currents of the Atlantic Ocean with those of the Pacific and state the points of similarity.

93. Trace and describe the course of the Gulf Stream, and compare it with the Kuro Shio as regards direction and influence.

94. What countries are influenced by the Gulf Stream? Of what special benefit is it to the British Isles ?

95. Show the relation which exists between permanent winds and the main ocean currents.

96. Describe the influences of currents on climate and commerce.

97. What are the tides ? In what respects do they differ from currents and waves ?

98. Why is the moon's power in producing tides greater than the sun's although the latter is much larger ?

99. Explain by means of a diagram, how tides are caused.

100. What do you understand by spring tides ? Describe with the help of a diagram how they take place.

101. What are neap tides and how are they caused.

102. Say what you know about the speed and height of tides.

103. Explain why the corresponding high tide next day occurs, not after 24 hours, but after 24 hours and 54 minutes.

104. What is a bore ? Where do bores generally occur ? Give instances.

105. Why are the tides of great importance to man.

106. Explain the following :

Range of the tides, co-tidal lines, high tide and low tide.

107. What is meant by the atmosphere ? What is it composed of ? How high does it extend ?

108. Explain the phenomena which result from the presence of water vapour in the air.

109. How is the atmosphere heated ? Why do we feel colder as we go up ? What is the effect of water-vapour on the temperature of the atmosphere ?

110. What is atmospheric pressure ? How is it measured ? In what way do heat, elevation, and water-vapour affect it ?

111. What do you understand by the distribution of pressure ? Show the connection between the permanent winds and the distribution of pressure.

112. What are trade winds and anti-trade winds ? How are they caused ? In what latitude do they blow ?

113. Describe and illustrate by a diagram, the belts of constant winds and calms on the earth's surface.

114. Explain how the rotation of the earth affects the direction of the permanent winds.

115. "The countries situated within the tropics have their eastern portions wetter while those lying outside the tropics have their western parts moister." Account for this and give examples.

116. How is it that most of the deserts of the world lie in or near the Calms of Cancer and Capricorn ? Give instances.

117. What are monsoons ? How are they caused ? Over what countries and at what seasons do they blow ?

118. Write notes on :

Mean temperature, range of temperature, isotherms, isobars, isohyets, cyclones, anti-cyclones, land and sea breezes, typhoons, evaporation and condensation heat equator and rain-gauge.

119. What do you understand by the term climate ? Differentiate it from weather.

120. What are the chief causes upon which the climate of a place depends ? Explain them and give examples.

121. Name the chief factors that determine the rainfall of a place. Give examples in each case.

122. State which regions of the world have a heavy rainfall and which a scanty rainfall. Give reasons and instances.

123. Name and describe the chief types of climate distributed over the surface of the earth.

124. Characterise the climate of a mountain from top to bottom.

125. Show the effects on the climate of a country of (a) elevation, (b) direction of the winds and (c) vegetation.

126. Describe fully the differences between a maritime and a continental climate. State the causes of the differences and give an example of each kind of climate.

127. What are the characteristics of a Mediterranean climate ? In what parts of the world is it met with ?

128. How does climate effect the life and activity of a man ? Explain and give illustrations.

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APPENDIX-III

Suggested Questions on Practical Geography

1. Describe exactly how the material obtained by the Meteorological Office, Poona, is plotted to form the daily weather map of India. What information can be had from the map ?

2. What is a weather chart ? How is it prepared ?

3. Give the principal features of the Indian Daily Weather Report to show your familiarity with it. When is it published and how are the data collected ?

4. What are the elements of weather ?

Differentiate between weather and climate.

5. (a) Describe carefully the data you would require for the construction of agricultural maps of Andhra Pradesh.

(b) Discuss and illustrate the methods you would adopt to construct a map of the Uttar Pradesh showing the distribution of wheat cultivation.

6. What are the various methods you would adopt to represent diagrammatically the statistics of production ? Illustrate.

7. What do you understand by the Dot system employed in the preparation of distributional maps ? What are its advantages ? When does this system fail ? Give examples.

8. What are the different methods of geographically representing geographical statistics ? Illustrate your answer with relevant diagrams.

9. Represent graphically the population (1961 Census) of the following states :

State :	*Population* :
Andhra Pradesh	35,983,447
Gujarat	20,633,350
Haryana	75,29,759
Kerala	1,69,03,715
Madhya Pradesh	3,23,72,408

10. Convert the following scales into R.F. :

(a) 6 inches to a mile (b) 1 centimetre to kilometre.

11. Construct a scale 4 inches to a mile.

12. Construct a scale of 1/100000 to show miles.

13. Change the following R.F. into statement :

(a) 1/5000000 to show how many miles are represented by one inch.

(b) 1/100000 to show how many inches represent one mile.

14. Find the R.F. of the following, 5 miles = 1 in. and 6 inches to a mile.

15. Measure out in miles from the railway map of India the distance between Delhi and Calcutta and Kanpur and Madras.

16. Expain when you would use a plane table for the making and when you would use the surveyor's chain. Give reasons

17. Draw a plan from the following readings :

	to D	
	600	
350 F——→	560	
	430	←——110 to C.
90 F——→	220	
	100	←——220 to B.
	0	measured in links
	A	

18. Give the names of the instruments required for plane table survey.

APPENDIX-IV

Suggested Questions in Lesson on Notes Plan

1. Write notes of a lesson on the distribution and occupation of population in India for the students of class X.

2. Plan a course of lessons, suitable for classes IV-X to help the students to form a correct idea of maps and realise that map is pre-eminently the geographer's tool both in investigation of problems and presentation of results.

3. Write notes of a lesson on the rivers of Asia for the students of class VI.

4. Plan a course of lessons, suitable for class IX and X to help the pupils to understand the basic principles of Physical Geography.

5. Write notes of a lesson on the Nile valley of Egypt for the students of class VII.

6. Plan a lesson note on any *one* of following topics :

(a) Glaciers for class IX.

(b) Distribution of rainfall in India for class X.

(c) Map Projection for class XI.

(d) Egypt for class VII.

APPENDIX-V

Books, Magazines and Atlases for Geography Library

1. Geography Books :

1. Peeps at Many Lands series, published by A.C. Black Ltd., London.
2. Black's Colour series
3. Black's pictures of many Lands.
4. Things seen series, published by Seeley Service & Co.
5. A set of Herbertson's Descriptive Geography published by A.C. Black.
6. Junior Geography Series by K.M.E. Elloy.
7. Where Winter Never Comes—Bates, Marston.
8. Our Earth, Arthur Beiser.
9. Mountains and Valleys—Hanover House, New York.
10. Rocks and Their Stories—Doubleday.
11. How the Earth is Made—P. Hood.
12. Things Maps Don't Tell us—A.K. Lobeck.
13. Picture Book of the Earth—J.S. Meyer.
14. Glacier's—Robert Sharp.
15. Air and Wind—Enc Stoane.
16. All about the Weather—Tennehill.
17. The Climate of India—S.K. Banerjee.
18. Industrial development in India since Independence—G. Kuriyan.
19. Present day India—P.K. Sen.
20. A General and Regional Geography by Unstead and Taylor.
21. Asia by Lyde.
22. Europe by Lyde or by Shanahan.
23. N. America by Lane.
24. S. America by Shanahan.
25. Africa by Suggate.

26. Australia by Fitzerald.
27. A Handbook of Commercial Geography by Chisholm.
28. Intermediate Commercial Geography by Dudley Stamp.
29. The World by L. Dudley Stamp.
30. Commercial Geography by Curr.
31. Physical Geography by P. Lake.
32. Physical basis of Geography by Woolridge.
33. Physical Geography by Gregory.
34. Physical Geography for Indian Students by Fox.
35. Sample influence of Geographic environment.
36. Fluer—Human Geography.
37. The Geographical Background of Modern Problems (Longmans).
38. Lyde—Man in many lands.
39. Climate by Kendrew.
40. Plant Geography by Hardy.
41. Statesman's Year Book.
42. India by Dr. Chibber (2 vols.)
43. India by Nazir and Mathur.
44. India by Mookerjee, Dubey & Dasgupta.
45. Earth, Moon, and Planets—F.L. Whipple.
46. Planet, Earth—Wyler Rose.
47. Life in the Universe—Ovenden.
48. Complete Book of Space Travel—A.T. Gaul.
49. Biography of the Earth—George Gamow.
50. The Same of Life—J.H. Rush.
51. The Earth Beneath us—H.H. Swinerton.
52. All about the Weather—I.R. Tennehill.
53. Volcanoes and Earthquakes—H.F. Pough.
54. Mining Round the World—J.M. Metcalfe.
55. Rocks and Their Stories.
56. How to know & Predict the Weather—R. Fither.
57. How old is the Earth—Patrick Hurby.
58. Sea and Shore—C.J. Hylander.
59. The Soils That Support Us—C.E. Kellogg.
60. Mapping the World—Rais Evwin.

II. Magazines :

1. National Geographical Magazine.

2. Times of India, Illustrated Weekly.
3. Indian Geographical Journal, Madras.
4. Bhugol—Allahabad.
5. Calcutta Geographical Magazine.
6. Geography Birmingham.
7. Bombay Geographical Magazine, Bombay.
8. Geographer, Muslim University, Aligarh.
9. Geographical Review, New York.
10. Geographical Review of India, Calcutta.
11. Geographical Outlook, Ranchi.
12. Indian Geographer, New Delhi.
13. National Geographical Journal of India, Varanasi.
14. National Geographer, Allahabad.
15. Observer, (Calcutta University Students Geographical Association, Calcutta).
16. Oriental Geographer, Dacca.
17. Deccan Geographer, Hyderabad.
18. Economic Geography (Mass), U.S.A.
19. Annals of the Association Geographers.
20. Geographer Teacher (Madras).
21. Bulletins of National Geographical Society of India (Varanasi).
22. Geographical Thought (Gorakhpur).
23. Geographical Observer (Meerut).
24. Indian Journal of Geography (Jodhpur).
25. Journal of Indian Society of Soil Science (New Delhi).
26. Journal of University of Sagar (Sagar).
27. Journal of United Service Institution of India.
28. Journal of Geographical Society of India (Bangalore).
29. Vidarbha Journal of Science.
30. Journal of Vikram University (Ujjain).
31. Agra University Journal of Research.
22. Baroda University Geography Series.

III. Atlases :

1. National Atlas of India, English Edition—Ministry of Scientific Research and Central Affairs, Government of India.

2, Bengal in Maps—S.P. Chatterjee.
3. India in Maps—Publications Division, Ministry of Information and Broadcasting, Delhi.
4. School Atlas, Survey of India, Dehra Dun.
5. National Atlas of India, Transport and Tourism—National Atlas Organisation, Calcutta.
6. An Advance Atlas.

APPENDIX-VI

Equipments of a Geography Room

1. **Meteorological Instruments :**

Rain Gauge, Wind Vane, Barometer, Tube Barometer, Aneroid Barometer, Reaumer Thermometer, Centigrade Thermometer, Maximum and Minimum Thermometer, Wet & Dry Bulb Thermometer.

2. **Survey Instruments :**

Plane Table, Spirit Level, Box Compass, Tripod, Poles, Flags, Chain and Arrows, Prismatic Compass, Survey Field Book, Tape, Alidade, Scale or Foot Rule, Compass, Divider, Protector.

3. **Geographical Instruments and Collections :**

    1. Globe and Wired Globe.
    2. Maps—Black Board Maps, Atlas Maps, Memory Maps, Picture Maps and Map stand.
    3. Pictures—Picture postcards and paintings.
    4. Magazines.
    5. Models—Models of Clay and Plasticine.
    6. Locally manufactured goods of cloth, pottery, wood, metal and lacquer.
    7. Agricultural products—rice, wheat, millets, tea, oil seeds and fibres etc.
    8. Rocks—Stones and Minerals.
    9. Stamp, Coins and Pamphlets.

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2. Mountains and Rivers of India—Indian National Committee for Geography, Cal. 1968.
3. Indian Regional Studies — -Do-
4. Abstracts of Papers — -Do-
5. Fifty Years of Science in India (Progress of Geography)—Indian Science Congress Association 1963.
6. Progress of Geography in India (1964-1968) — -Do- 1968.
7. Training Science—Walter A. Thurber and Alfred T. Collette.
8. New Matriculation Geography—W. Bell, M.A., C.I.E.,
9. Teaching of Geography—Welpton.
10. Principles and Practice of Teaching of Geography—E.A. Macnee.
11. Text Book of Geography—Fry.
12. Memorandum on the Teaching of Geography by an Association of Assistant Masters in Secondary Schools—George Phillip and Sons, London.
13. Climate—Kendrew.
14. Mapwork—Bryant.
15. History of Geography—J. Scott Keltie and O.J.R. Howrath.
16. Earth, Moon and Planets—F.L. Whipple.
17. The Crust of the Earth—S. Rapport.
18. Glaciers—Robert Sharp.
19. Clouds, Air and Wind—Eric Stoane.

20, Time, Life and Man—R.A. Stirton.

51. All About the Sea—Lane Ferdinand.
22. Mountains and Valleys—Hanover House, New York.

23, Teaching Science in the Secondary Schools—R. W. Burnett.

24. Policies for Science Education —F.L. Fitzpatrik.
25. Modern Science Teaching —Heiss, Obourn & Hoffman.
26. Secondary School Science Teaching —A. Hoff.
27. Methods & Materials in Teaching the Biological Sciences —A.F. Miller & Blaydes.
28. Calcutta Geographical Review (Calcutta).
29. National Geographical Journal of India (Varanasi).
30. Geography Teacher (Madras).
31. Journal of Indian Society of Soil Science (New Delhi).
32. Journal of United Service Institution of India.
33. Proceedings of Seminar on Geomorphological Studies in India (Sagar).
34. Transaction of the Indian Council of Geographers (Patna).
35. Agra University Journal of Research.

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